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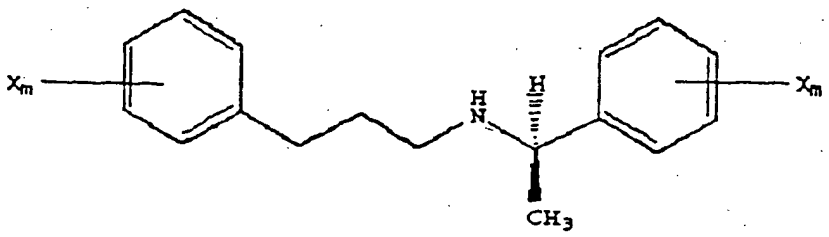

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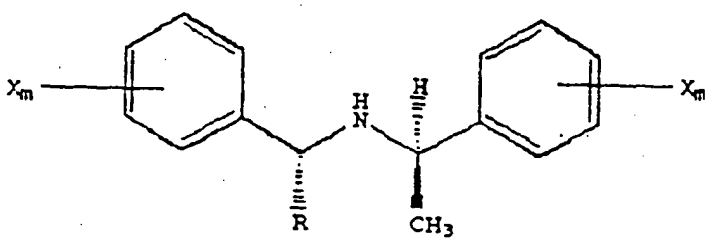

(II)

(57) Abstract

The present invention features molecules with general structure (I) or (II) which can modulate on or activities of an inorganic ion receptor. Preferably, the molecule can mimic or block the effect of extracellular Ca^{2+} on a calcium receptor. The preferred use of such molecules is to treat diseases or disorders by altering inorganic ion receptor activity, preferably calcium receptor activity.

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DESCRIPTION

Calcium receptor-active arylalkyl amines

FIELD OF THE INVENTION

This invention relates to the design, development, composition and use of novel molecules able to modulate the activity of inorganic ion receptor.

BACKGROUND OF THE INVENTION

Certain cells in the body respond not only to chemical signals, but also to ions such as extracellular calcium ions (Ca^{2+}). Changes in the concentration of extracellular Ca^{2+} (referred to herein as "$[Ca^{2+}]$") alter the functional responses of these cells. One such specialized cell is the parathyroid cell which secretes parathyroid hormone (PTH). PTH is the principal endocrine factor regulating Ca^{2+} homeostasis in the blood and extracellular fluids.

PTH, by acting on bone and kidney cells, increases the level of Ca^{2+} in the blood. This increase in $[Ca^{2+}]$ then acts as a negative feedback signal, depressing PTH secretion. The reciprocal relationship between $[Ca^{2+}]$ and PTH secretion forms the essential mechanism maintaining bodily Ca^{2+} homeostasis.

Extracellular Ca^{2+} acts directly on parathyroid cells to regulate PTH secretion. The existence of a parathyroid cell surface protein which detects changes in $[Ca^{2+}]$ has been confirmed. Brown *et al.*, 366 Nature 574, 1993. In parathyroid cells, this protein acts as a receptor for extracellular Ca^{2+} ("the calcium receptor"), and detects changes in $[Ca^{2+}]$ and to initiate a functional cellular response, PTH secretion.

Extracellular Ca^{2+} can exert effects on different cell functions, reviewed in Nemeth *et al.*, 11 Cell Calcium 319, 1990. The role of extracellular Ca^{2+} in parafollicular (C-cells) and parathyroid cells is discussed in Nemeth, 11 Cell Calcium 323, 1990. These cells have been shown to express similar Ca^{2+} receptor. Brown *et al.*, 366 Nature 574, 1993; Mithal et al., 9 Suppl. 1 J. Bone and Mineral

Res. s282, 1994; Rogers *et al.*, 9 Suppl. 1 J. Bone and Mineral Res. s409, 1994; Garrett *et al.*, 9 Suppl. 1 J. Bone and Mineral Res. s409, 1994. The role of extracellular Ca^{2+} on bone osteoclasts is discussed by Zaidi, 10 Bioscience Reports 493, 1990. In addition keratinocytes, juxtaglomerular cells, trophoblasts, pancreatic beta cells and fat/adipose cells all respond to increases in extracellular calcium which likely reflects activation of calcium receptors of these cells.

The ability of various compounds to mimic extracellular Ca^{2+} *in vitro* is discussed by Nemeth *et al.*, (spermine and spermidine) in "Calcium-Binding Proteins in Health and Disease," 1987, Academic Press, Inc., pp. 33-35; Brown *et al.*, (*e.g.*, neomycin) 128 Endocrinology 3047, 1991; Chen *et al.*, (diltiazem and its analog, TA-3090) 5 J. Bone and Mineral Res. 581, 1990; and Zaidi *et al.*, (verapamil) 167 Biochem. Biophys. Res. Commun. 807, 1990. Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959, and Nemeth *et al.*, PCT/US92/07175, International Publication Number WO 93/04373, describe various compounds which can modulate the effect of an inorganic ion on a cell having an inorganic ion receptor, preferably modulate the effects of calcium on a calcium receptor.

The references provided in the background are not admitted to be prior art.

SUMMARY OF THE INVENTION

The present invention features molecules which can modulate one or activities of an inorganic ion receptor. Preferably, the molecule can mimic or block the effect of extracellular Ca^{2+} on a calcium receptor. The preferred use of such molecules is to treat diseases or disorders by altering inorganic ion receptor activity, preferably calcium receptor activity.

Extracellular Ca^{2+} is under tight homeostatic control and controls various processes such as blood clotting, nerve and muscle excitability, and proper bone formation.

Calcium receptor proteins enable certain specialized cells to respond to changes in extracellular Ca^{2+} concentration. For example, extracellular Ca^{2+} inhibits the secretion of parathyroid hormone from parathyroid cells, inhibits bone resorption by osteoclasts, and stimulates secretion of calcitonin from C-cells.

Compounds modulating inorganic ion receptor activity can be used to treat diseases or disorders by affecting one or more activities of an inorganic ion receptor resulting in a beneficial effect to the patient. For example, osteoporosis is an age related disorder characterized by loss of bone mass and increased risk of bone fracture. Compounds blocking osteoclastic bone resorption either directly (*e.g.*, a osteoclast ionmimetic compound) or indirectly by increasing endogenous calcitonin levels (*e.g.*, a C-cell ionmimetic), and/or by decreasing parathyroid hormone levels (*e.g.*, a parathyroid cell ionmimetic) can retard bone loss and, thus, result in beneficial effects to patients suffering from osteoporosis.

In addition, it is known that intermittent low dosing with PTH results in an anabolic effect on bone mass and appropriate bone remodeling. Thus, compounds and dosing regiments evoking transient increases in parathyroid hormone (*e.g.*, intermittent dosing with a parathyroid cell ionlytic) can increase bone mass in patients suffering from osteoporosis.

Additionally, diseases or disorders characterized by a defect in one or more inorganic ion receptor activities may be treated by the present invention. For example, certain forms of primary hyperparathyroidism are characterized by abnormally high levels of parathyroid hormone and decreased parathyroid gland responsiveness to circulating calcium. Calcium receptor modulating agents can be used to modulate parathyroid cell responsiveness to calcium.

Preferably, the compound modulates calcium receptor activity and is used in the treatment of diseases or disorders which can be affected by modulating one or more activities of a calcium receptor. Preferably, the disease or disorder is characterized by abnormal bone and mineral homeostasis, more preferably calcium homeostasis.

Abnormal calcium homeostasis is characterized by one or more of the following activities: (1) an abnormal increase or decrease in serum calcium; (2) an abnormal increase or decrease in urinary excretion of calcium; (3) an abnormal increase or decrease in bone calcium levels, for example, as assessed by bone mineral density measurements; (4) an abnormal absorption of dietary calcium; and (5) an abnormal increase or decrease in the production and/or release of circulating messengers or hormones which affect calcium homeostasis such as parathyroid hormone and calcitonin. The abnormal increase or decrease in these different aspects of calcium homeostasis is relative to that occurring in the general population and is generally associated with a disease or disorder.

More generally, a molecule which modulates the activity of an inorganic ion receptor is useful in the treatment of diseases characterized by abnormal inorganic ion homeostasis. Preferably, the molecule modulates one or more effects of an inorganic ion receptor. Inorganic ion receptor modulating agents include ionmimetics, ionlytics, calcimimetics, and calcilytics.

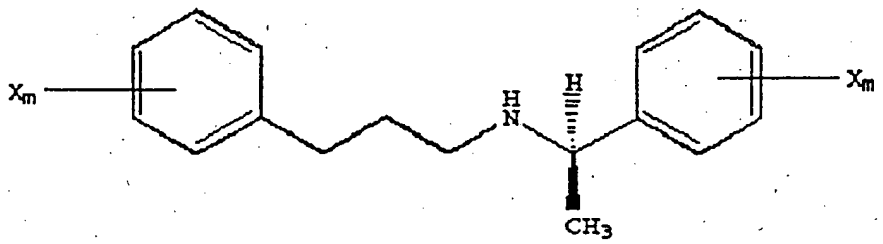
Ionmimetics are molecules which mimic the effects of increasing ion concentration at an inorganic ion receptor. Preferably, the molecule affects one or more calcium receptor activities. Calcimimetics are ionmimetics which affect one or more calcium receptor activities and preferably binds to a calcium receptor.

Ionlytics are molecules which reduce or block one or more activities caused by an inorganic ion on an inorganic ion receptor. Preferably, the molecule inhibits one or

more calcium receptor activities. Calcilytics are ionlytics which inhibit one or more calcium receptor activities evoked by extracellular calcium and preferably bind to a calcium receptor.

Inorganic ion receptor modulating agents can be formulated as pharmacological agents or compositions to facilitate administration in a patient. Pharmacological agents or compositions are agents or compositions in a form suitable for administration into a mammal, preferably a human. Considerations concerning forms suitable for administration are known in the art and include toxic effects, solubility, route of administration, and maintaining activity.

Thus, a first aspect the invention features an inorganic ion receptor modulating agent comprising a molecule which either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activity caused by an extracellular inorganic ion. The molecule has the formula:



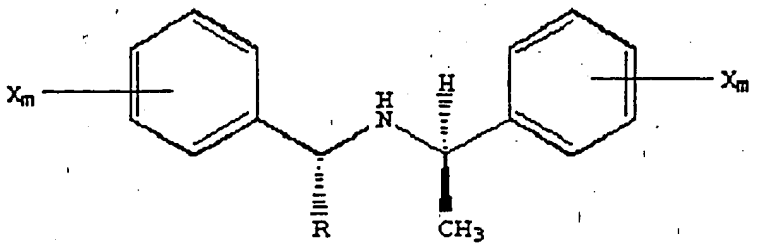
where each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, an aliphatic ring and an attached or fused aromatic ring; and

each m is independently between 0 and 5 inclusive.

Preferably, the aromatic and aliphatic rings have 5 to 7 members. More preferably, the aromatic and aliphatic rings contain only carbon atoms (*i.e.*, the ring is not a heterocyclic ring).

Preferably, the molecule either evokes one or more calcium receptor activities, or blocks one or more calcium receptor activities caused by extracellular calcium.

Another aspect of the present invention features an inorganic ion receptor modulating agent having the formula:



where each X independently is selected from the group consisting of H, CH_3, CH_3O, CH_3CH_2O, methylene dioxy, Br, Cl, F, CF_3, CHF_2, CH_2F, CF_3O, CH_3S, OH, CH_2OH, $CONH_2$, CN, NO_2, CH_3CH_2, propyl, isopropyl, butyl, isobutyl, t-butyl, acetoxy, aliphatic ring and an attached or fused aromatic ring;

each R independently is selected from the group consisting of hydrogen, methyl, ethyl, propyl, isopropyl, butyl, allyl, isobutyl, t-butyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, indenyl, indanyl, dihydroindolyl, thiodihydroindolyl, and 2-, 3-, or 4- piperid(in)yl; and

each m is independently between 0 and 5 inclusive.

The molecule either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion. Preferably, the molecule either evokes one or more calcium receptor activities, or blocks one or more calcium receptor activities caused by extracellular calcium.

In preferred embodiments R is either H, CH_3, ethyl, or isopropyl, and each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, aliphatic ring and an attached or fused aromatic ring. Preferably, the aliphatic ring and attached or fused aromatic ring have 5 to 7 members. More preferably, the aromatic and aliphatic rings contain only carbon atoms.

Another aspect of the present invention features an inorganic ion receptor modulating agent comprising a molecule selected from the group consisting of compound 4L, compound 8J, compound 8U, compound 9R, compound 11X, compound 12U, compound 12V, compound 12Z, compound 14U, compound 16M and compound 16P.

Other aspects of the present invention feature methods for using the agents described herein for treating diseases or disorders by modulating inorganic ion receptor activity. Patients in need of such treatments can be identified by standard medical techniques, such as routine blood analysis. For example, by detecting a deficiency of protein whose production or secretion is affected by changes in inorganic ion concentrations, or by detecting abnormal levels of inorganic ions or hormones which effect inorganic ion homeostasis.

Therapeutic methods involve administering to the patient a therapeutically effective amount of an inorganic ion receptor modulating agent. In preferred embodiments these methods are used to treat a disease or disorder characterized by abnormal inorganic ion homeostasis, more preferably a disease or disorder characterized by abnormal calcium homeostasis. Diseases and disorders characterized by abnormal calcium homeostasis include hyperparathyroidism, osteoporosis and other bone and mineral-related disorders, and the like (as described, *e.g.*, in standard medical text books, such as "Harrison's Principles of Internal Medicine"). Such diseases and disorders are treated using calcium receptor modulating agents which mimic or block one or more of the effects of Ca^{2+} and, thereby, directly or indirectly affect the levels of proteins or other molecules in the body of the patient.

By "therapeutically effective amount" is meant an amount of an agent which relieves to some extent one or more symptoms of the disease or disorder in the patient; or returns to normal either partially or completely one or

more physiological or biochemical parameters associated with or causative of the disease or disorder.

In a preferred embodiment, the patient has a disease or disorder characterized by an abnormal level of one or more calcium receptor regulated components and the molecule is active on a calcium receptor of a cell selected from the group consisting of parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, trophoblast in the placenta, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune-cell and GI tract cell.

More preferably, the cell is a parathyroid cell and the molecule reduces the level of parathyroid hormone in the serum of the patient, even more preferably the level is reduced to a degree sufficient to cause a decrease in plasma Ca^{2+}, most preferably the parathyroid hormone level is reduced to that present in a normal individual.

Thus, the present invention features agents and methods useful in the treatment of diseases and disorders by modulating inorganic ion receptor activity. For example, the molecules of the present invention can be used to target calcium receptors on different cell types that detect and respond to changes to external calcium. For example, molecules mimicking external calcium may be used to selectively depress secretion of parathyroid hormone from parathyroid cells, or depress bone resorption by osteoclasts, or stimulate secretion of calcitonin from C-cells. Such molecules can be used to treat diseases or disorders characterized by abnormal calcium homeostasis such as hyperparathyroidism and osteoporosis.

Other features and advantages of the invention will be apparent from the following description of the preferred embodiments thereof and from the claims.

BRIEF DESCRIPTION OF THE DRAWING

Figs. 1A-D, 2A-D, 3A-E, 4A-E, 5A-D, 6A-E, 7A-E, 8A-E, 9A-F, 10A-E, 11A-E, 12A-D, 13A-D, 14A-D, 15A-D, 16A-D, 17A-D, 18A-E, 19A-D, and 20A-D show the chemical structures of molecules derived from diphenylpropyl-α-phenethylamine illustrating a family of molecules which were prepared and screened to find the useful molecules of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention describes inorganic ion receptor modulating agents able to mimic or block an effect of an inorganic ion at an inorganic ion receptor. The preferred use of inorganic ion receptor modulating agents is to treat a disease or disorder by modulating inorganic ion receptor activity. Preferably, the molecules are used to treat diseases or disorders characterized by abnormal ion homeostasis, more preferably abnormal calcium homeostasis. Other uses of inorganic ion receptor modulating agents, such as diagnostics uses, are known in the art. Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959.

I. CALCIUM RECEPTORS

Calcium receptors and nucleic acid encoding calcium receptors are described by Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959. Calcium receptors are present on different cell types such as parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, trophoblast in the placenta, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-

secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, and GI tract cell. The calcium receptor on these

cell types may be different. It is also possible that a cell can have more than one type of calcium receptor.

Comparison of calcium receptor activities and amino acid sequences from different cells indicate that distinct calcium receptor types exist. For example, calcium receptors can respond to a variety of di- and trivalent cations. The parathyroid calcium receptor responds to calcium and Gd^{3+}, while osteoclasts respond to divalent cations such as calcium but does not respond to Gd^{3+}. Thus, the parathyroid calcium receptor is pharmacologically distinct from calcium receptor on the osteoclast.

On the other hand, the nucleic acid sequences encoding calcium receptors present in parathyroid cells and C-cells indicate that these receptors have a very similar amino acid structure. Nevertheless, calcimimetic compounds exhibit differential pharmacology and regulate different activities at parathyroid cells and C-cells. Thus, pharmacological properties of calcium receptors may vary significantly depending upon the cell type or organ in which they are expressed even though the calcium receptors may have similar structures.

Calcium receptors, in general, have a low affinity for extracellular Ca^{2+} (apparent K_d generally greater than about 0.5 mM). Calcium receptors may include a free or bound effector mechanism as defined by Cooper, Bloom and Roth, "The Biochemical Basis of Neuropharmacology", Ch. 4, and are thus distinct from intracellular calcium receptors, *e.g.*, calmodulin and the troponins.

Calcium receptors respond to changes in extracellular calcium levels. The exact changes depend on the particular receptor and cell line containing the receptor. For example, the *in vitro* effect of calcium on the calcium receptor in a parathyroid cell include the following:

1. An increase in internal calcium. The increase is due to the influx of external calcium and/or

mobilization of internal calcium. Characteristics of the increase in internal calcium include the following:

(a) A rapid (time to peak < 5 seconds) and transient increase in $[Ca^{2+}]_i$ that is refractory to inhibition by 1 μM La^{3+} or 1 μM Gd^{3+} and is abolished by pretreatment with ionomycin (in the absence of extracellular Ca^{2+});

(b) The increase is not inhibited by dihydropyridines;

(c) The transient increase is abolished by pretreatment for 10 minutes with 10 mM sodium fluoride;

(d) The transient increase is diminished by pretreatment with an activator of protein kinase C (PKC), such as phorbol myristate acetate (PMA), mezerein or (-)-indolactam V. The overall effect of the protein kinase C activator is to shift the concentration-response curve to calcium to the right without affecting the maximal response; and

(e) Treatment with pertussis toxin (100 ng/ml for > 4 hours) does not affect the increase.

2. A rapid (< 30 seconds) increase in the formation of inositol-1,4,5-triphosphate or diacylglycerol. Treatment with pertussis toxin (100 ng/ml for > 4 hours) does not affect this increase;

3. The inhibition of dopamine- and isoproterenol-stimulated cyclic AMP formation. This effect is blocked by pretreatment with pertussis toxin (100 ng/ml for > 4 hours); and

4. The inhibition of PTH secretion. Treatment with pertussis toxin (100 ng/ml for > 4 hours) does not affect the inhibition in PTH secretion.

Using techniques known in the art, the effect of calcium on other calcium receptors in different cells can be readily determined. Such effects may be similar in regard to the increase in internal calcium observed in parathyroid cells. However, the effect is expected to

differ in other aspects, such as causing or inhibiting the release of a hormone other than parathyroid hormone.

II. INORGANIC ION RECEPTOR MODULATING AGENTS

Inorganic ion receptor modulating agents either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion. Calcium receptor modulating agents can mimic or block an effect of extracellular Ca^{2+} on a calcium receptor. Preferred calcium receptor modulating agents are calcimimetics and calcilytics. Generic and specific structures of inorganic ion receptor modulating agents are provided in the Summary *supra*, and in Figure 1.

Inorganic ion receptor modulating agents can be identified by screening molecules which are modelled after a molecule shown to have a particular activity (i.e., a lead molecule). Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959.

Preferred inorganic ion receptor modulation agents described by the present invention are compounds are 8J, 8U, 9R, 11X, 12U, 12V, 12Z, 14U, 16M, and 16P. These compounds all have EC_{50} values of less than 5 μM.

The EC_{50} is the concentration of the molecule which evokes a half-maximal effect. The IC_{50} is the concentration of molecule which causes a half-maximal blocking effect. The EC_{50} or IC_{50} can be determined by assaying one or more of the activities of an inorganic ion at an inorganic ion receptor. Preferably, such assays are specific to a particular calcium receptor. For example, assays which measure hormones whose production or secretion is modulated by a particular inorganic ion receptor are preferred.

Increases in $[Ca^{2+}]_i$ can be detected using standard techniques such as by using fluorimetric indicators or by measuring an increase in Cl^- current in a *Xenopus* oocyte injected with nucleic acid coding for a calcium receptor. Nemeth *et al.*, PCT/US93/01642, International Publication

Number WO 94/18959. For example, poly(A)$^+$ mRNA can be obtained from cells expressing a calcium receptor, such as a parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, central nervous cell, peripheral nervous system cell, trophoblast in the placenta, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, and GI tract cell. Preferably, the nucleic acid is from a parathyroid cell, C-cell, or osteoclast. More preferably, the nucleic acid encodes a calcium receptor and is present on a plasmid or vector.

Preferably, the molecule is either a calcimimetic or calcilytic having an EC_{50} or IC_{50} at a calcium receptor of less than or equal to 5 μM, and even more preferably less than or equal to 1 μM, 100 nmolar, 10 nmolar, or 1 nmolar. Such lower EC_{50}'s or IC_{50}'s are advantageous since they allow lower concentrations of molecules to be used *in vivo* or *in vitro* for therapy or diagnosis. The discovery of molecules with such low EC_{50}'s and IC_{50}'s enables the design and synthesis of additional molecules having similar potency and effectiveness.

In preferred embodiments the calcium receptor modulating agent is a calcimimetic which inhibits parathyroid hormone secretion from a parathyroid cell *in vitro* and decreases PTH secretion *in vivo*; stimulates calcitonin secretion from a C-cell *in vitro* and elevates calcitonin levels *in vivo*; or blocks osteoclastic bone resorption *in vitro* and inhibits bone resorption *in vivo*.

In another preferred embodiment the calcium receptor modulating agent is a calcilytic which evokes the secretion of parathyroid hormone from parathyroid cells *in*

vitro and elevates the level of parathyroid hormone *in vivo*.

Preferably, the agent selectively targets inorganic ion receptor activity, more preferably calcium receptor activity, in a particular cell. By "selectively" is meant that the molecule exerts a greater effect on inorganic ion receptor activity in one cell type than at another cell type for a given concentration of agent. Preferably, the differential effect is 10-fold or greater. Preferably, the concentration refers to blood plasma concentration and the measured effect is the production of extracellular messengers such as plasma calcitonin, parathyroid hormone or plasma calcium. For example, in a preferred embodiment, the agent selectively targets PTH secretion over calcitonin secretion.

In another preferred embodiment, the molecule has an EC_{50} or IC_{50} less than or equal to 5 μM at one or more, but not all cells chosen from the group consisting of parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, central nervous system cell, peripheral nervous system cell, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, trophoblast in the placenta, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell and GI tract cell.

Preferably, inorganic ion receptor modulating agents mimic or block all of the effects of extracellular ion in a cell having an inorganic ion receptor. For example, calcium receptor modulating agents preferably mimic or block all of the effects of extracellular ion in a cell having a calcium receptor. Calcimimetics need not possess all the biological activities of extracellular Ca^{2+}, but, rather, at least one such activity is mimicked.

Similarly, calcilytics need not reduce or prevent all of the activities caused by extracellular calcium. Additionally, different calcimimetics and different calcilytics do not need to bind to the same site on the calcium receptor as does extracellular Ca^{2+} to exert their effects.

A. Calcimimetics

The ability of molecules to mimic or block the activity of Ca^{2+} at calcium receptors can be determined using procedures known in the art and described by Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959. For example, calcimimetics possess one or more and preferably all of the following activities when tested on parathyroid cells *in vitro*:

1. The molecule causes a rapid (time to peak < 5 seconds) and transient increase in $[Ca^{2+}]_i$ that is refractory to inhibition by 1 μM La^{3+} or 1 μM Gd^{3+}. The increase in $[Ca^{2+}]_i$ persists in the absence of extracellular Ca^{2+} but is abolished by pretreatment with ionomycin (in the absence of extracellular Ca^{2+});

2. The molecule potentiates increases in $[Ca^{2+}]_i$ elicited by submaximal concentrations of extracellular Ca^{2+};

3. The increase in $[Ca^{2+}]_i$ elicited by extracellular Ca^{2+} is not inhibited by dihydropyridines;

4. The transient increase in $[Ca^{2+}]_i$ caused by the molecule is abolished by pretreatment for 10 minutes with 10 mM sodium fluoride;

5. The transient increase in $[Ca^{2+}]_i$ caused by the molecule is diminished by pretreatment with an activator of protein kinase C (PKC), such as phorbol myristate acetate (PMA), mezerein or (-)-indolactam V. The overall effect of the protein kinase C activator is to shift the concentration-response curve of the molecule to the right without affecting the maximal response;

6. The molecule causes a rapid (< 30 seconds) increase in the formation of inositol-1,4,5-triphosphate and/or diacylglycerol;

7. The molecule inhibits dopamine- or isoproterenol-stimulated cyclic AMP formation;

8. The molecule inhibits PTH secretion;

9. Pretreatment with pertussis toxin (100 ng/ml for > 4 hours) blocks the inhibitory effect of the molecule on cyclic AMP formation but does not effect increases in $[Ca^{2+}]_i$, inositol-1,4,5-triphosphate, or diacylglycerol, nor decreases in PTH secretion;

10. The molecule elicits increases in Cl^- current in *Xenopus* oocytes injected with poly(A)$^+$- enriched mRNA from bovine or human parathyroid cells, but is without effect in *Xenopus* oocytes injected with water, or rat brain or liver mRNA; and

11. Similarly, using a cloned calcium receptor from a parathyroid cell, the molecule will elicit a response in *Xenopus* oocytes injected with the specific cDNA or mRNA encoding the receptor.

Different calcium activities can be measured using available techniques. Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959. Parallel definitions of molecules mimicking Ca^{2+} activity on other calcium responsive cell, preferably at a calcium receptor, are evident from the examples provided herein and Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959.

Preferably, the agent as measured by the bioassays described herein, or by Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959, has one or more, more preferably all of the following activities: evokes a transient increase in internal calcium, having a duration of less that 30 seconds (preferably by mobilizing internal calcium); evokes a rapid increase in $[Ca^{2+}]_i$, occurring within thirty seconds; evokes a sustained increase (greater than thirty seconds) in $[Ca^{2+}]_i$

(preferably by causing an influx of external calcium); evokes an increase in inositol-1,4,5-triphosphate or diacylglycerol levels, preferably within less than 60 seconds; and inhibits dopamine- or isoproterenol-stimulated cyclic AMP formation.

The transient increase in $[Ca^{2+}]_i$ is preferably abolished by pretreatment of the cell for ten minutes with 10 mM sodium fluoride, or the transient increase is diminished by brief pretreatment (not more than ten minutes) of the cell with an activator of protein kinase C, preferably, phorbol myristate acetate (PMA), mezerein or (-) indolactam V.

B. Calcilytics

The ability of a molecule to block the activity of external calcium can be determined using standard techniques. Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959. For example, molecules which block the effect of external calcium, when used in reference to a parathyroid cell, possess one or more, and preferably all of the following characteristics when tested on parathyroid cells *in vitro*:

1. The molecule blocks, either partially or completely, the ability of increased concentrations of extracellular Ca^{2+} to:

(a) increase $[Ca^{2+}]_i$;

(b) mobilize intracellular Ca^{2+},

(c) increase the formation of inositol-1,4,5-triphosphate,

(d) decrease dopamine- or isoproterenol-stimulated cyclic AMP formation, and

(e) inhibit PTH secretion;

2. The molecule blocks increases in Cl^- current in *Xenopus* oocytes injected with poly(A)$^+$ mRNA from bovine or human parathyroid cells elicited by extracellular Ca^{2+} or calcimimetic compounds, but not in *Xenopus* oocytes injected with water or liver mRNA;

3. Similarly, using a cloned calcium receptor from a parathyroid cell, the molecule will block a response in *Xenopus* oocytes injected with the specific cDNA, mRNA or cRNA encoding the calcium receptor, elicited by extracellular Ca^{2+} or a calcimimetic compound.

Parallel definitions of molecules blocking Ca^{2+} activity on a calcium responsive cell, preferably at a calcium receptor, are evident from the examples provided herein and Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959..

III. TREATMENT OF DISEASES OR DISORDERS

A preferred use of the compounds described by the present invention is in the treatment or prevention of different diseases or disorders by modulating inorganic ion receptor activity. The inorganic ion receptor modulating agents of the present invention can exert an affect on a inorganic ion receptor causing one or more cellular effects ultimately producing a therapeutic effect.

Different diseases and disorders can be treated by the present invention by targeting cells having an inorganic ion receptor, such as a calcium receptor. For example, primary hyperparathyroidism (HPT) is characterized by hypercalcemia and elevated levels of circulating PTH. A defect associated with the major type of HPT is a diminished sensitivity of parathyroid cells to negative feedback regulation by extracellular Ca^{2+}. Thus, in tissue from patients with primary HPT, the "set-point" for extracellular Ca^{2+} is shifted to the right so that higher than normal concentrations of extracellular Ca^{2+} are required to depress PTH secretion. Moreover, in primary HPT, even high concentrations of extracellular Ca^{2+} often depress PTH secretion only partially. In secondary (uremic) HPT, a similar increase in the set-point for extracellular Ca^{2+} is observed even though the degree to which Ca^{2+} suppresses PTH secretion is normal. The changes in PTH secretion are paralleled by changes in $[Ca^{2+}]_i$: the

set-point for extracellular Ca^{2+}-induced increases in $[Ca^{2+}]_i$ is shifted to the right and the magnitude of such increases is reduced.

Molecules that mimic the action of extracellular Ca^{2+} are beneficial in the long-term management of both primary and secondary HPT. Such molecules provide the added impetus required to suppress PTH secretion which the hypercalcemic condition alone cannot achieve and, thereby, help to relieve the hypercalcemic condition. Molecules with greater efficacy than extracellular Ca^{2+} may overcome the apparent nonsuppressible component of PTH secretion which is particularly troublesome in adenomatous tissue. Alternatively or additionally, such molecules can depress synthesis of PTH, as prolonged hypercalcemia has been shown to depress the levels of preproPTH mRNA in bovine and human adenomatous parathyroid tissue. Prolonged hypercalcemia also depresses parathyroid cell proliferation *in vitro*, so calcimimetics can also be effective in limiting the parathyroid cell hyperplasia characteristic of secondary HPT.

Cells other than parathyroid cells can respond directly to physiological changes in the concentration of extracellular Ca^{2+}. For example, calcitonin secretion from parafollicular cells in the thyroid (C-cells) is regulated by changes in the concentration of extracellular Ca^{2+}.

Isolated osteoclasts respond to increases in the concentration of extracellular Ca^{2+} with corresponding increases in $[Ca^{2+}]_i$ that arise partly from the mobilization of intracellular Ca^{2+}. Increases in $[Ca^{2+}]_i$ in osteoclasts are associated with the inhibition of bone resorption. Release of alkaline phosphatase from bone-forming osteoblasts is directly stimulated by calcium.

Renin secretion from juxtaglomerular cells in the kidney, like PTH secretion, is depressed by increased concentrations of extracellular Ca^{2+}. Extracellular Ca^{2+} causes the mobilization of intracellular Ca^{2+} in these cells. Other kidney cells respond to calcium as follows:

elevated Ca^{2+} inhibits formation of $1,25(OH)_2$-vitamin D by proximal tubular cells, stimulates production of calcium-binding protein in distal tubular cells, and inhibits tubular reabsorption of Ca^{2+} and Mg^{2+} and the action of vasopressin on the medullary thick ascending limb of Henle's loop (MTAL), reduces vasopressin action in the cortical collecting duct cells, and affects vascular smooth muscle cells in blood vessels of the renal glomerulus.

Calcium also promotes the differentiation of intestinal goblet cells, mammary cells, and skin cells; inhibits atrial natriuretic peptide secretion from cardiac atria; reduces cAMP accumulation in platelets; alters gastrin and glucagon secretion; acts on vascular smooth muscle cells to modify cell secretion of vasoactive factors; and affects cells of the central nervous system and peripheral nervous system.

Thus, there are sufficient indications to suggest that Ca^{2+}, in addition to its ubiquitous role as an intracellular signal, also functions as an extracellular signal to regulate the responses of certain specialized cells. Molecules of this invention can be used in the treatment of diseases or disorders associated with disrupted Ca^{2+} responses in these cells.

Specific diseases and disorders which might be treated or prevented, based upon the affected cells, also include those of the central nervous system such as seizures, stroke, head trauma, spinal cord injury, hypoxia-induced nerve cell damage such as in cardiac arrest or neonatal distress, epilepsy, neurodegenerative diseases such as Alzheimer's disease, Huntington's disease and Parkinson's disease, dementia, muscle tension, depression, anxiety, panic disorder, obsessive-compulsive disorder, post-traumatic stress disorder, schizophrenia, neuroleptic malignant syndrome, and Tourette's syndrome; diseases involving excess water reabsorption by the kidney such as syndrome of inappropriate ADH secretion (SIAH),

cirrhosis, heart failure, and nephrosis; hypertension; preventing and/or decreasing renal toxicity from cationic antibiotics (*e.g.*, aminoglycoside antibiotics); gut motility disorders such as diarrhea, and spastic colon; GI ulcer diseases; GI absorption diseases such as sarcoidosis; and autoimmune diseases and organ transplant rejection.

While inorganic ion receptor modulating agents of the present invention will typically be used in therapy for human patients, they may be used to treat similar or identical diseases or disorders in other warm-blooded animal species such as other primates, farm animals such as swine, cattle, and poultry; and sports animals and pets such as horses, dogs and cats.

IV. ADMINISTRATION

The molecules of the invention can be formulated for a variety of modes of administration to treat patients by modulating inorganic ion receptor activity. Techniques and formulations for administration of compounds generally may be found in Remington's Pharmaceutical Sciences, Mack Publishing Co., Easton, PA. Administration of ionmimetics and ionlytics is discussed by Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959.

Suitable forms, in part, depend upon the use or the route of entry, for example oral, transdermal, or by injection. Such forms should allow the agent to reach a target cell whether the target cell is present in a multicellular host or in culture. For example, pharmacological agents or compositions injected into the blood stream should be soluble in the concentrations used. Other factors are known in the art, and include considerations such as toxicity and forms which prevent the agent or composition from exerting its effect.

Agents can also be formulated as pharmaceutically acceptable salts (*e.g.*, acid addition salts) and complexes thereof. The preparation of such salts can facilitate the

pharmacological use by altering the physical characteristics of the agent without preventing it from exerting its physiological effect. Examples of useful alterations in physical properties include lowering the melting point to facilitate transmucosal administration and increasing the solubility to facilitate administering higher concentrations of the drug.

For systemic administration, oral administration is preferred. Alternatively, injection may be used, *e.g.*, intramuscular, intravenous, intraperitoneal, and subcutaneous. For injection, the molecules of the invention are formulated in liquid solutions, preferably in physiologically compatible buffers such as Hank's solution or Ringer's solution. In addition, the molecules may be formulated in solid form and redissolved or suspended immediately prior to use. Lyophilized forms can also be produced.

Systemic administration can also be by transmucosal or transdermal means, or the molecules can be administered orally. For transmucosal or transdermal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art, and include, for example, for transmucosal administration, bile salts and fusidic acid derivatives. In addition, detergents may be used to facilitate permeation. Transmucosal administration may be through nasal sprays, for example, or using suppositories. For oral administration, the molecules are formulated into conventional oral administration dosage forms such as capsules, tablets, and tonics.

For topical administration, the molecules of the invention are formulated into ointments, salves, gels, or creams, as is generally known in the art.

Generally, a therapeutically effective amount is between about 1 nmole and 3 μmole of the molecule, preferably 0.1 nmole and 1 μmole depending on its EC_{50} or IC_{50} and on the age and size of the patient, and the

disease or disorder associated with the patient. Generally it is an amount between about 0.1 and 50 mg/kg, preferably 0.01 and 20 mg/kg, animal to be treated.

V. EXAMPLES

The compounds described herein can be synthesized using standard techniques such as those described by Nemeth *et al.*, PCT/US93/01642, International Publication Number WO 94/18959. Examples describing the syntheses of compounds 4L, 8J, 8U, 9R, 11X, 12U, 12V, 12Z, 14U, 16M and 16P are provided below. Compounds 4L, 8J, 8U, 11X and 16M were prepared from the condensation of a primary amine with an aldehyde or ketone in the presence of titanium(IV) isopropoxide. The resulting intermediate imines were then reduced *in situ* by the action of sodium cyanoborohydride, sodium borohydride, or sodium triacetoxyborohydride. The intermediate enamine for the synthesis of compound 8U was catalytically reduced using palladium hydroxide.

Synthesis of compounds 9R, 14U, and 16P were prepared by reductive amination of a commercially available aldehyde or ketone with a primary amine in the presence of sodium cyanoborohydride or sodium triacetoxyborohydride. It was found for the syntheses of these three compounds (9R, 14U, and 16P) that sodium triacetoxyborohydride afforded the desired diastereomers with greater diastereoselectivity than using sodium cyanoborohydride. The enriched mixtures were further purified to a single diastereomer by normal-phase HPLC or by recystallization from organic solvents.

Compounds 12U, 12V and 12Z were prepared by a diisobutylaluminum hydride (DIBAL-H) mediated condensation of an amine with a nitrile. The resulting intermediate imine is reduced *in situ* by the action of sodium cyanoborohydride or sodium borohydride. The intermediate alkenes (compounds 12U and 12V) were reduced by catalytic hydrogenation in EtOH using palladium on carbon. Compounds which were converted to their corresponding

hydrochloride were done so by treatment of the free base with ethereal HCl to afford white solids.

The amines in these syntheses were (1) purchased from Aldrich Chemical Co., Milwaukee, WI, (2) purchased from Celgene Corp., Warren, NJ, or (3) prepared synthetically using standard techniques. All other reagent chemicals were purchased from Aldrich Chemical Co.

Example 1: Synthesis of Compound 4L

N-3-Phenyl-1-propyl-1-(1-naphthyl)ethylamine

A mixture of 3-phenyl-1-propylamine (135 mg, 1 mmol), 1'-acetonaphthone (170 mg, 1 mmol), and titanium (IV) isopropoxide (355 mg, 1.3 mmol) was stirred at room temperature for 1 hour. The reaction was treated with 1 M ethanolic sodium cyanoborohydride (1 mL) and stirred at room temperature for 16 hours. The reaction was diluted with ether and treated with water (0.1 mL). The reaction was centrifuged and the ether layer removed and concentrated to a milky oil. A small portion of this material (10 mg) was purified by HPLC (Phenomenex, 1.0 x 25 cm, 5 μM silica) using a gradient of dichloromethane to 10% methanol in dichloromethane containing 0.1% isopropylamine. This afforded the product (free base) as a single component by GC/El-MS (R_t= 10.48 min) m/z (rel. int.) 289 (M^+,11), 274 (63), 184 (5), 162 (5), 155 (100), 141 (18), 115 (8), 91 (45), 77(5).

Example 2: Synthesis of Compound 8J

N-(3-phenylpropyl)-1-(3-thiomethylphenyl)ethylamine hydrochloride

3'-Aminoacetophenone (2.7 g, 20 mmol) was dissolved in 4 mL of concentrated HCl, 4 g of ice and 8 mL of water. The solution was cooled to 0°C, and sodium nitrite (1.45 g, 21 mmol) dissolved in 3-5 mL of water was added over 5 minutes while maintaining the temperature below 6°C. Sodium thiomethoxide (1.75 g, 25 mmol) was dissolved in 5 mL of water and cooled to 0°C. To this solution was added

the diazonium salt over 10 minutes while maintaining the temperature below 10°C. The reaction was stirred for an additional hour while allowing the temperature to rise to ambient. The reaction mixture was partitioned between ether and water. The ether layer was separated and washed with sodium bicarbonate and sodium chloride, and dried over sodium sulfate. The ether was evaporated to give a 74% yield of 3'-thiomethylacetophenone. The crude material was purified by distillation at reduced pressure.

3-Phenylpropylamine (0.13 g, 1 mmol), 3'-thiomethylacetophenone (0.17 g, 1 mmol), and titanium (IV) isopropoxide (0.36 g, 1.25 mmol) were mixed together and allowed to stand for 4 hours. Ethanol (1 mL) and sodium cyanoborohydride (0.063 g, 1 mmol) were added and the reaction was stirred overnight. The reaction was worked up by the addition of 4 mL of ether and 200 μL of water. The mixture was vortexed and then spun in a centrifuge to separate the solids. The ether layer was separated from the precipitate, and the solvent removed *in vacuo*. The oil was redissolved in dichloromethane and the compound purified by preparative TLC on silica gel eluted with 3% methanol/dichloromethane to yield the title compound as a pure oil: GC/EI-MS(R_t=7.64 min) m/z (rel. int.)285 (M^+,18), 270(90), 180(17), 151(100), 136(32), 104(17), 91(54), 77(13).

Example 3: Synthesis of Compound 8U

N-3-(2-methoxyphenyl)-1-propyl-(R)-3-methoxy-α-methylbenzylamine hydrochloride

A mixture of (*R*)-(+)-3-methoxy-α-methylbenzylamine (3.02 g, 20 mmol), 2-methoxycinnamaldehyde (3.24 g, 20 mmol), and titanium (IV) isopropoxide (8.53 g, 30 mmol, 1.5 Eq.) was stirred 2 hours at room temperature and treated with 1 M (20 mL) ethanolic sodium cyanoborohydride. The reaction was stirred overnight (16 hours), diluted with diethylether, and treated with water (1.44 mL, 80 mmol, 4 Eq.). After mixing for 1 hour the

reaction mixture was centrifuged and the ether layer removed and concentrated to an oil. This material was dissolved in glacial acetic acid, shaken with palladium hydroxide and hydrogenated under 60 p.s.i. hydrogen for 2 hours at room temperature. The catalyst was removed by filtration and the resulting solution concentrated to a thick oil. This material was dissolved in dichloromethane and neutralized with 1 N NaOH. The dichloromethane solution was separated from the aqueous phase, dried over anhydrous potassium carbonate and concentrated to an oil. This material was dissolved in ether and treated with 1 M HCl in diethylether. The resulting precipitate (white solid) was collected, washed with diethylether, and air dried. GC/El-MS (R_t = 9.69 min) of this material (free base) showed a single component: m/z (rel. int.) 299 (M+, 21), 284 (100), 164 (17), 150 (8), 135 (81), 121 (40), 102 (17), 91 (43), 77 (18).

Example 4: Synthesis of Compound 9R

(R)-N-(1-(2-naphthyl)ethyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride

A mixture of (*R*)-(+)-1-(1-naphthyl)ethylamine (10.0 g, 58 mmol), 2'-acetonaphthone (9.4 g, 56 mmol), titanium (IV) isopropoxide (20.7 g, 73.0 mmol), and EtOH (abs.) (100 mL) was heated to 60°C for 3 hours. Sodium cyanoborohydride ($NaCNBH_3$) (3.67 g, 58.4 mmol) was then added. The reaction mixture was stirred at room temperature for 18 hours. Ether (1 L) and H_20 (10 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was recrystallized four times from hot hexane, to provide 1.5 g of pure (98+%) diastereomer. The free base was dissolved in hexane, filtered, and then ethereal HCl was added to precipitate the product as a white solid (1.1 g, 6 % yield), m.p.: softens 200-240 °C (dec.).

Example 5: Synthesis of Compound 11X

N-(4-Isopropylbenzyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride

A mixture of (*R*)-(+)-1-(1-naphthyl)ethylamine (1.06 g, 6.2 mmol), 4-isopropylbenzaldehyde (0.92 g, 6.2 mmol), and titanium (IV) isopropoxide (2.2 g, 7.7 mmol) was heated to 100°C for 5 min then allowed to stir at room temperature for 4 hours. Sodium cyanoborohydride ($NaCNBH_3$) (0.39 g, 6.2 mmol) was then added followed by EtOH (1 mL). The reaction mixture was stirred at room temperature for 18 hours. Ether (100 mL) and H_2O (1 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (50 mm X 30 cm column) (elution with 1% $MeOH/CHCl_3$). The chromatographed material was then dissolved in hexane and ethereal HCl was added to precipitate the product as a white solid (0.67 g, 35 % yield), m.p.; 257-259°C.

Example 6: Synthesis of Compound 12U

N-3-(2-methylphenyl)-1-propyl-(R)-3-methoxy-α-methylbenzylamine hydrochloride

A solution of 2-methylcinnamonitrile (1.43 g, 10 mmol) in dichloromethane (10 mL) was cooled to 0°C and treated dropwise (15 minutes) with 1 M diisobutylaluminum hydride (10 mL, dichloromethane). The reaction was stirred at 0°C for 15 minutes and treated dropwise (15 minutes) with a 1 M solution of (*R*)-(+)-3-methoxy-α-methylbenzylamine (1.51 g, 10 mmol) in dichloromethane (10 mL). The reaction was stirred 1 hours at 0°C and poured into a solution of ethanol (100 mL) containing sodium cyanoborohydride (1 g, 16 mmol). The reaction mixture was stirred 48 hour at room temperature. The reaction was diluted with ether and neutralized with 1 N NaOH. The ether layer was removed, dried over anhydrous potassium carbonate and concentrated to an oil. This material was

chromatographed through silica using a gradient of dichloromethane to 5% methanol in dichloromethane to afford the unsaturated intermediate, a single component by GC/El-MS (R_t=10.06 min) m/z (rel. int.) 281 (M+, 17), 266 (59), 176 (19), 146 (65), 135 (73), 131 (100), 91 (21), 77 (13).

The unsaturated intermediate in ethanol was hydrogenated (1 atm H_2) in the presence of palladium on carbon for 16 hours at room temperature. The product from this reaction was converted to the hydrochloride salt by treatment with 1 M HCl in diethylether. GC/El-MS (R_t = 9.31 min) of this material (free base) showed a single component: m/z (rel. int.) 283 (M+, 21), 268 (100), 164 (12), 148 (8), 135 (85), 121 (12), 105 (49), 91 (23), 77 (21).

Example 7: Synthesis of Compound 12V

N-3-(3-methylphenyl)-1-propyl-(R)-3-methoxy-α-methylbenzylamine hydrochloride

The compound was prepared following the procedure described in Example 6, but using 2-methylcinnamonitrile. The unsaturated intermediate was a single component by GC/EI-MS (R_t = 10.21 min) m/z (rel. int.) 281 (M+, 57), 266 (86), 146 (98), 135 (88), 131 (100), 115 (43), 102 (26), 91 (43), 77 (18). Reduction of this material and hydrochloride formation using the procedure described Example 6 afforded the product. GC/EI-MS (R_t = 9.18 min) of this material (free base) showed a single component; m/z (rel. int.) 283 (M+, 19), 268 (100), 164 (11), 148 (8), 135 (76), 121 (16), 105 (45), 91 (23), 77 (21).

Example 8: Synthesis of Compound 12Z

N-3-(2-chlorophenyl)-1-propyl-(R)-1-(1-naphthyl)ethylamine hydrochloride

The compound was prepared following the procedures described in Example 6, but using 2-chlorohydrocinnamonitrile and (*R*)-(+)-1-(1-

naphthyl)ethylamine on a 10 mmol scale. Chromatography through silica using a gradient of dichloromethane to 5% methanol in dichloromethane afforded the product as a single component by TLC analysis (5% methanol in dichloromethane). The hydrochloride was prepared by treatment with 1 M HCl in diethylether.

Example 9: Synthesis of Compound 14U

(R)-N-(1-(4-methoxyphenyl)ethyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride

A mixture of (*R*)-(+)-1-(1-naphthyl)ethylamine (1.1 g, 6.2 mmol), 4'-methoxyacetophenone (0.93 g, 6.2 mmol), titanium (IV) isopropoxide (2.2 g, 7.7 mmol); and EtOH (abs.) (1 mL) was heated to 60°C for 3 hours. Sodium cyanoborohydride ($NaCNBH_3$) (0.39 g, 6.2 mmol) was then added, and the reaction mixture was stirred at room temperature for 18 hours. Ether (200 mL) and H_2O (2 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (25 mm X 25 cm column) (elution with 1% MeOH/$CHCl_3$). A portion of this material was HPLC chromatographed [Selectosil, 5 μM silica gel; 25 cm x 10.0 mm (Phenomenex, Torrance, CA), 4 mL per minute; UV det. 275 nM; 12% ethyl acetate-88% hexane (elution time 12.0 min)]. The HPLC purified diastereomer was then dissolved in hexanes and ethereal HCl was added to precipitate the product as a white solid (20 mg), m.p.: 209-210°C(dec.).

Example 10: Synthesis of Compound 16M

N-(3-chloro-4-methoxybenzyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride

A mixture of (*R*)-(+)-1-(1-naphthyl)ethylamine (6.6 g, 39 mmol), 3'-chloro-4'-methoxybenzaldehyde (6.6 g, 39 mmol), and titanium (IV) isopropoxide (13.8 g, 48.8 mmol), and EtOH (abs.) (30 mL) was heated to 80°C for 30 minutes

then allowed to stir at room temperature for 3 hours. Sodium cyanoborohydride ($NaCNBH_3$) (2.45 g, 39 mmol) was then added. The reaction mixture was stirred at room temperature for 18 hours. Ether (100 mL) and H_2O (2 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (50 mm X 30 cm column) (elution with CH_2Cl_2). The chromatographed material was then dissolved in hexane (500 mL), decolorized with Norit® filtered (0.2 μM), and then ethereal HCl was added to precipitate the product as a while solid (10.2 g, 56 % yield), m.p.: 241-242°C (dec.).

Example 11: Synthesis of Compound 16P

4-Methoxy-3-methylacetophenone [16P Precursor]

A mixture of 4'-hydroxy-3'-methylacetophenone (5.0 g, 33.3 mmol), iodomethane (5.7 g, 40.0 mmol), K_2CO_3 (granular, anhydrous) (23.0 g, 167 mmol), and acetone (250 mL) was refluxed for 3 hours. The reaction mixture was then cooled to room temperature, filtered to remove the inorganic salts, and evaporated under vacuum. The crude product was dissolved in ether (100 mL) and washed with H_2O (2 x 20 mL). The organic layer was dried (Na_2SO_4) and evaporated to yield 4.5 g, 82.4% yield. The ketone was used in the following reaction without further purification.

(R)-N-(1-(4-Methoxy-3-methylphenyl)ethyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride [Compound 16P]

A mixture of (*R*)-(+)-1-(1-naphthyl)ethylamine (4.24 g, 24.8 mmol), 4'-methoxy-3'-methylacetophenone (4.06 g, 24.8 mmol), and titanium (IV) isopropoxide(8.8 g, 30.9 mmol), and EtOH (abs.) (1 mL) was heated to 100°C for 2 hours. Isopropanol (45 mL) was added and the reaction was then cooled to 10°C in an ice bath. Sodium triacetoxyborohydride ($NaHB(O_2CCH_3)_3$) (10.5 g, 49.5 mmol)

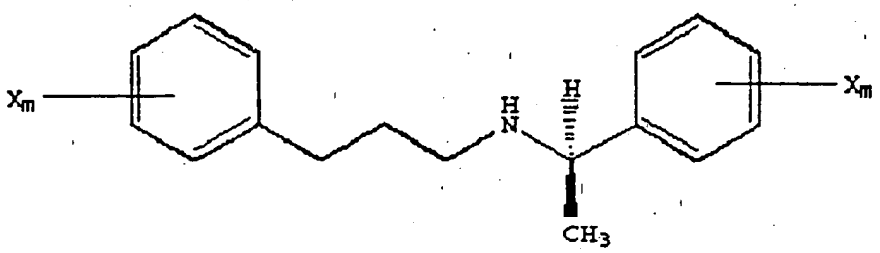
was then added in portions over 15 minutes. The reaction mixture was then heated to 70°C for 18 hours. The mixture was cooled to room temperature and poured into ether (400 mL). The suspension was centrifuged, the supernatant was collected and the pellet was washed with ether (400 mL). The combined organic washings were evaporated under vacuum. The residue was dissolved in ether (400 mL) and washed with 1 N NaOH (4 x 50 mL) and H_2O (2 x 50 mL). The organic layer was dried (Na_2SO_4), filtered and evaporated under vacuum. EtOH (abs.) was added to the wet residue which was then dried thoroughly on a rotary evaporator to provide an oil. The mixture was then chromatographed on silica gel (50 mm x 30 cm) [elution with (1% MeOH:1% IPA:$CHCl_3$) to give 4.8 g of an oil].

The desired diastereomer was further purified by HPLC chromatography [SUPELCOSIL™ PLC-Si, 18 μM silica gel; 25 cm x 21.2 mm (Supelco, Inc., Bellefonte, PA), 7 mL per minute; UV det. 275 nM: 20% EtOAc-80% hexane (elution time 9.5 - 11.0 min)]. Injections (800 μL aliquots) of the mixture (100 mg/mL solution in eluent) provided 65 mg of the desired isomer. Multiple HPLC injections provided 1.0 g of purified material. The HPLC chromatographed material was dissolved in hexane (50 mL) and the hydrochloride salt was precipitated with ethereal HCl. The salt was collected on fritted glass and washed with hexane to provide 1.0 g of a white solid, mp 204-205°C.

Other embodiments are within the following claims.

Claims

1. An inorganic ion receptor modulating agent comprising a molecule having the formula:

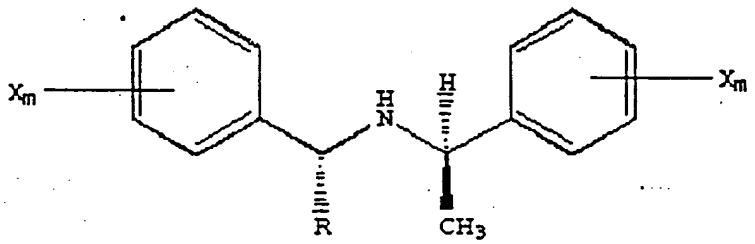


wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O an aliphatic ring and an attached or fused aromatic ring; and

each m is independently between 0 and 5 inclusive; wherein said molecule either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion.

2. The agent of claim 1 wherein said molecule is a calcimimetic and said inorganic ion receptor activity is a calcium receptor activity.

3. An inorganic ion receptor modulating agent comprising a molecule having the formula:



wherein each X independently is selected from the group consisting of H, CH_3, CH_3O, CH_3CH_2O, methylene dioxy, Br, Cl, F, CF_3, CHF_2, CH_2F, CF_3O, CH_3S, OH, CH_2OH, $CONH_2$, CN,

NO_2, CH_3CH_2, propyl, isopropyl, butyl, isobutyl, t-butyl, acetoxy, aliphatic ring and an attached or fused aromatic ring;

each R independently is selected from the group consisting of hydrogen, methyl, ethyl, propyl, isopropyl, butyl, allyl, isobutyl, t-butyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, indenyl, indanyl, dihydroindolyl, thiodihydroindolyl, and 2-, 3-, or 4- piperid(in)yl; and

each m is independently between 0 and 5 inclusive; wherein said molecule either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion.

4. The agent of claim 3 wherein said molecule is a calcimimetic and said inorganic ion receptor activity is a calcium receptor activity.

5. The agent of claim 4 wherein each R is independently selected from the group consisting of H, CH_3, ethyl, and isopropyl.

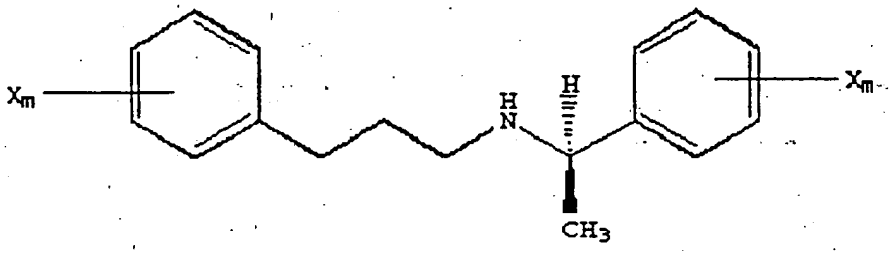
6. The agent of claim 4 wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, aliphatic ring and an attached or fused aromatic ring.

7. The agent of claim 5 wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, aliphatic ring and an attached or fused aromatic ring.

8. An inorganic ion receptor modulation agent comprising a molecule selected from the group consisting of compound 4L, compound 8J, compound 8U, compound 9R, compound 11X, compound 12U, compound 12V, compound 12Z, compound 14U, compound 16M, and compound 16P.

9. An agent of any claim 1-8 further comprising a physiologically acceptable carrier.

10. A method for treating a patient comprising the step of administering a therapeutically effective amount of an inorganic ion receptor modulating agent to a patient in need of such treatment, said agent comprising a molecule having the formula:



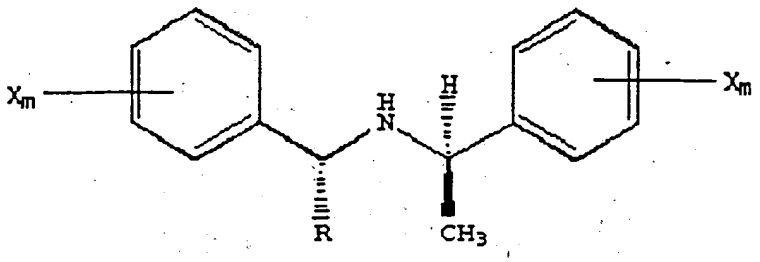
wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O an aliphatic ring and an attached or fused aromatic ring; and

each m is independently between 0 and 5 inclusive;

wherein said molecule either evokes in one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion.

11. The agent of claim 10 wherein said molecule is a calcimimetic and said inorganic ion receptor activity is a calcium receptor activity.

12. A method for treating a patient comprising the step of administering a therapeutically effective amount of an inorganic ion receptor modulating agent to a patient in need of such treatment, said agent comprising a molecule having the formula:



wherein each X independently is selected from the group consisting of H, CH_3, CH_3O, CH_3CH_2O, methylene dioxy, Br, Cl, F, CF_3, CHF_2, CH_2F, CF_3O, CH_3S, OH, CH_2OH, $CONH_2$, CN, NO_2, CH_3CH_2, propyl, isopropyl, butyl, isobutyl, *t*-butyl, acetoxy, aliphatic ring and an attached or fused aromatic ring;

each R independently is selected from the group consisting of hydrogen, methyl, ethyl, propyl, isopropyl, butyl, allyl, isobutyl, *t*-butyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, indenyl, indanyl, dihydroindolyl, thiodihydroindolyl, and 2-, 3-, or 4- piperid(in)yl; and

each m is independently between 0 and 5 inclusive;

wherein said molecule either evokes one or more inorganic ion receptor activities, or blocks one or more inorganic ion receptor activities caused by an extracellular inorganic ion.

13. The method of claim 12 wherein said patient has a disease or disorder characterized by abnormal calcium homeostasis, said molecule is a calcimimetic and said inorganic ion receptor activity is a calcium receptor activity.

14. The method of claim 13 wherein each R is independently selected from the group consisting of H, CH_3, ethyl, and isopropyl.

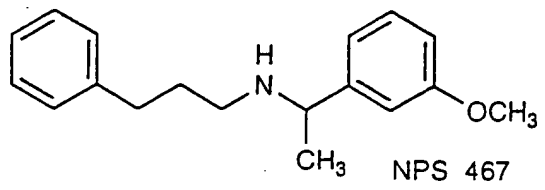
15. The method of claim 13 wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, aliphatic ring and an attached or fused aromatic ring.

16. The method of claim 14 wherein each X is independently selected from the group consisting of isopropyl, CH_3O, CH_3S, CF_3O, aliphatic ring and an attached or fused aromatic ring.

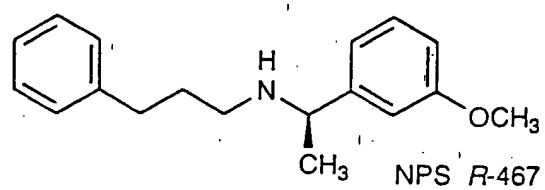
17. A method for treating a patient by modulating inorganic ion receptor activity comprising the step of administering to said patient a therapeutically effective amount of a molecule selected from the group consisting of compound 4L, compound 8J, compound 8U, compound 9R, compound 11X, compound 12U, compound 12V, compound 12Z, compound 14U, compound 16M, and compound 16P.

18. The method of claim 17 wherein said patient has a disease or disorder characterized by abnormal calcium homeostasis.

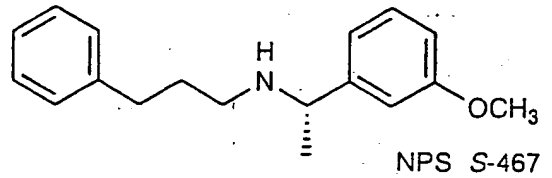
19. The method of any claim 12-17 wherein said patient has a disease selected from the group consisting of primary and secondary hyperparathyroidism, Paget's disease, hypercalcemia malignancy, osteoporosis and hypertension.



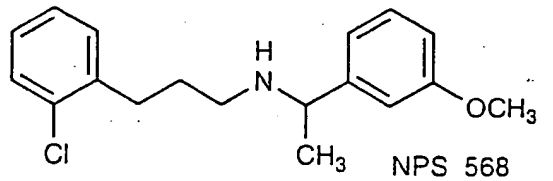
NPS 467



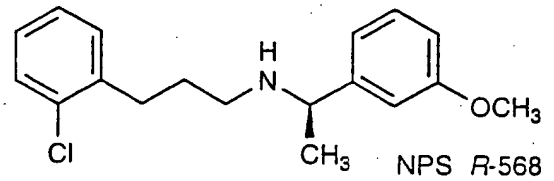
NPS *R*-467



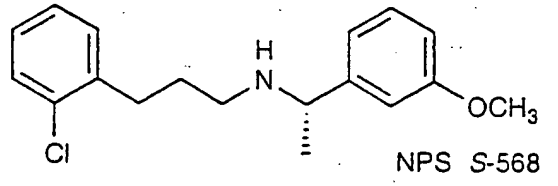
NPS *S*-467



NPS 568



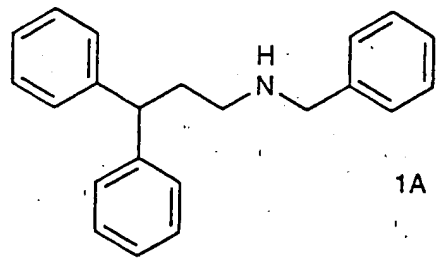
NPS *R*-568



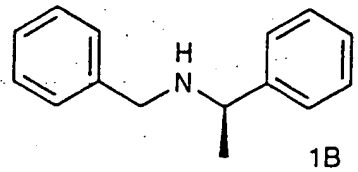
NPS *S*-568

FIG. 1A.

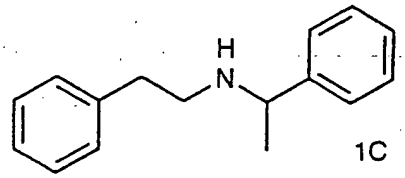
RECTIFIED SHEET (RULE 91)
ISA / EP



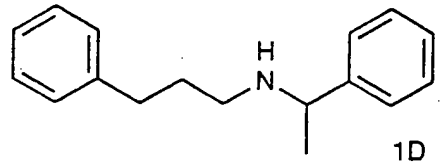
1A



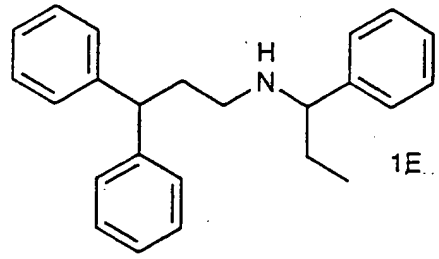
1B



1C

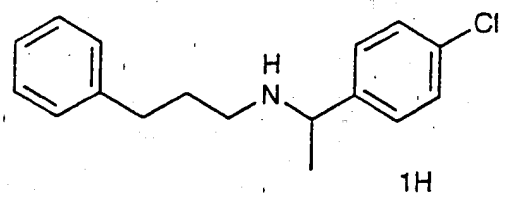


1D

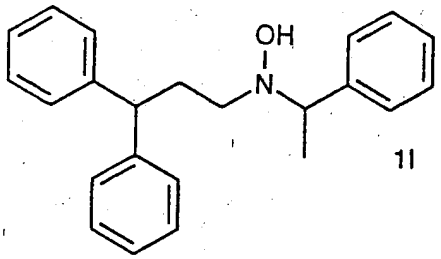


1E

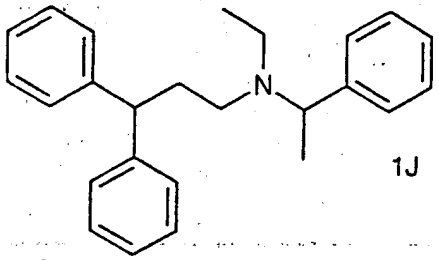
FIG. 1B.



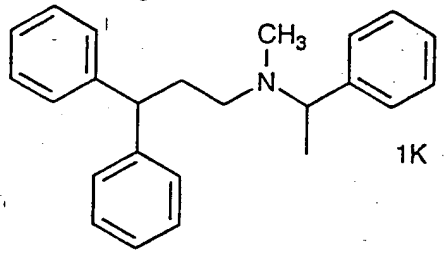
1H



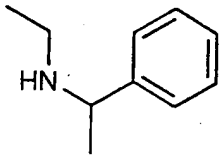
1I



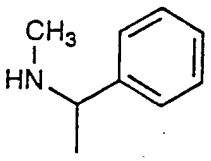
1J



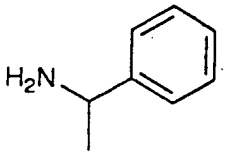
1K



1L



1M



1N

FIG. 1C.

RECTIFIED SHEET (RULE 91)
ISA / EP

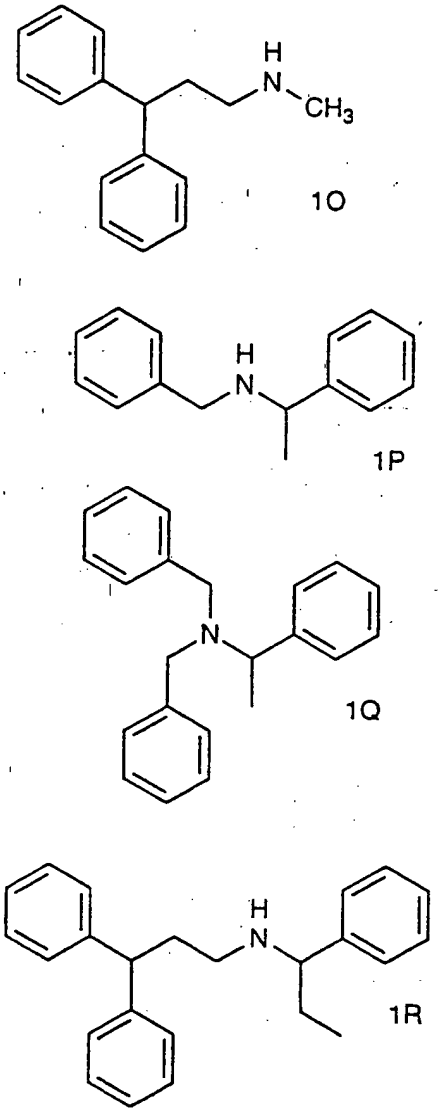
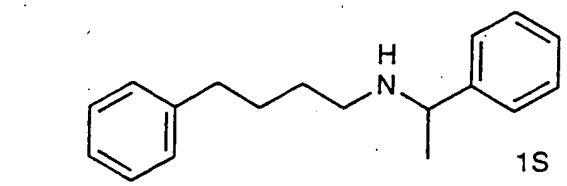
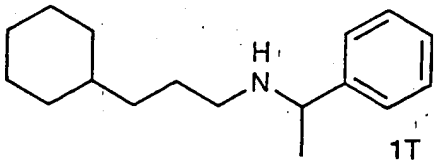


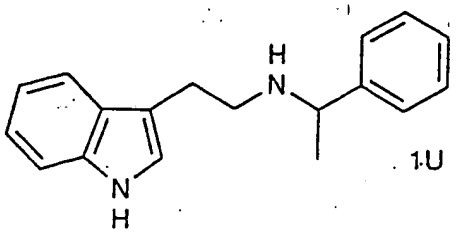
FIG. 1D.



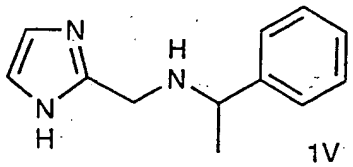
1S



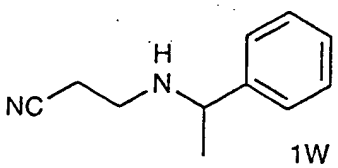
1T



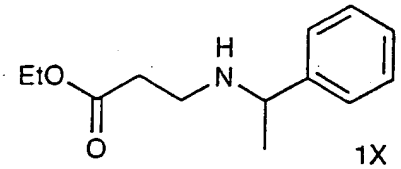
1U



1V

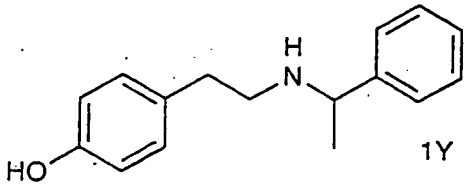


1W

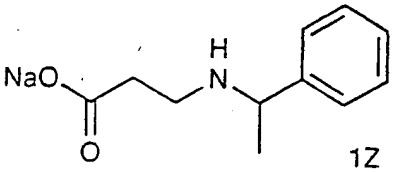


1X

FIG. 1E.



1Y



1Z

RECTIFIED SHEET (RULE 91)
ISA / EP

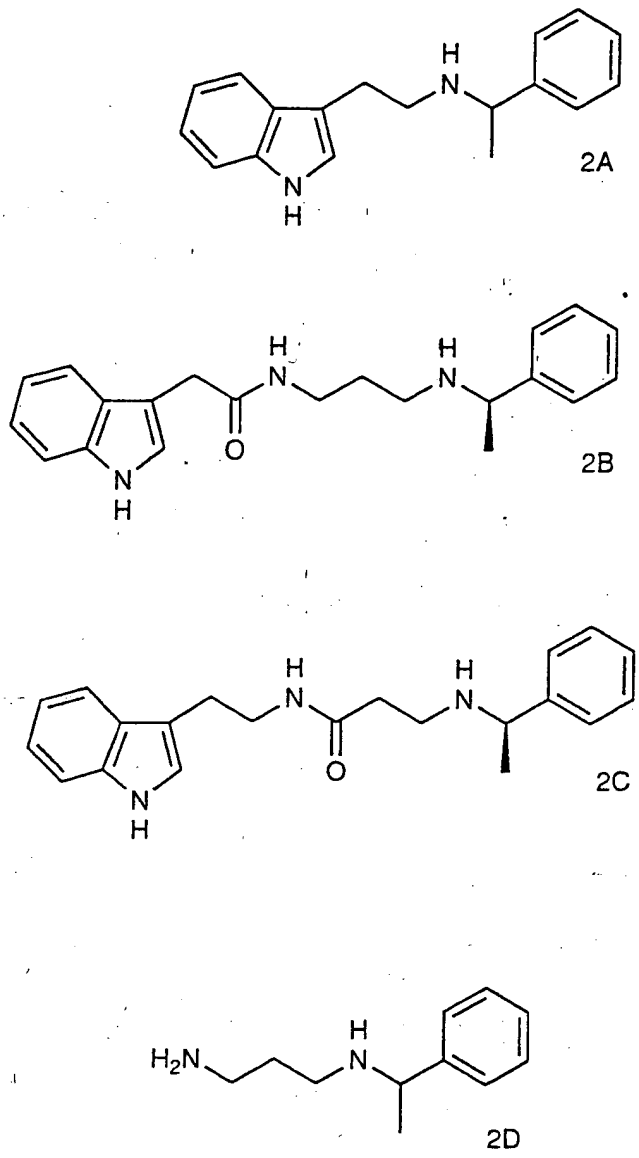


FIG. 2A.

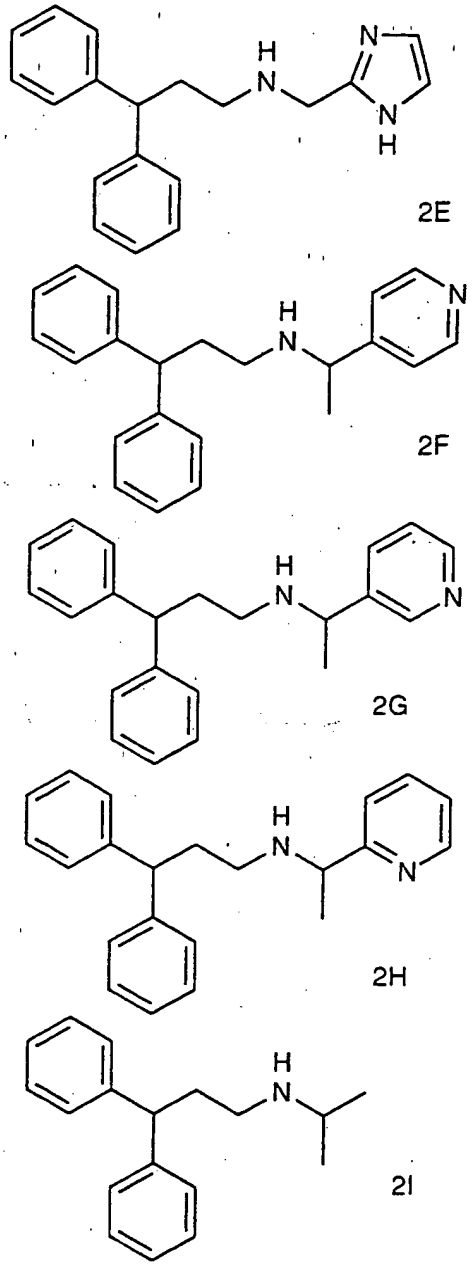


FIG.2B.

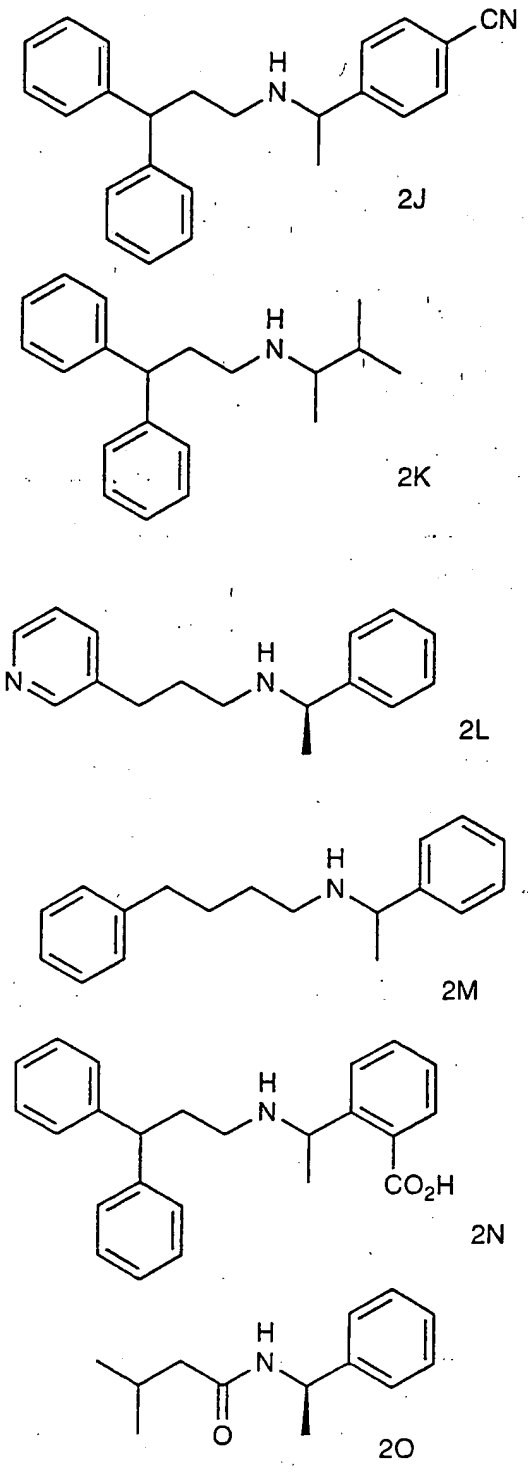


FIG. 2C.

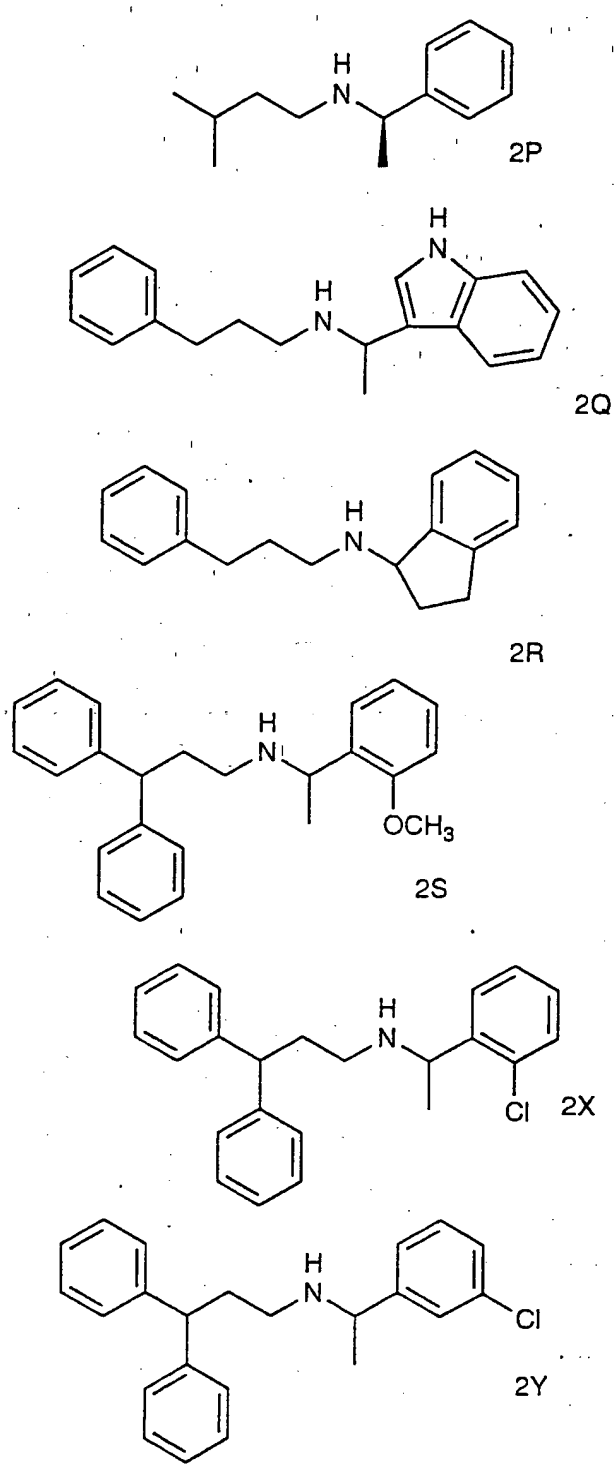


FIG. 2D.

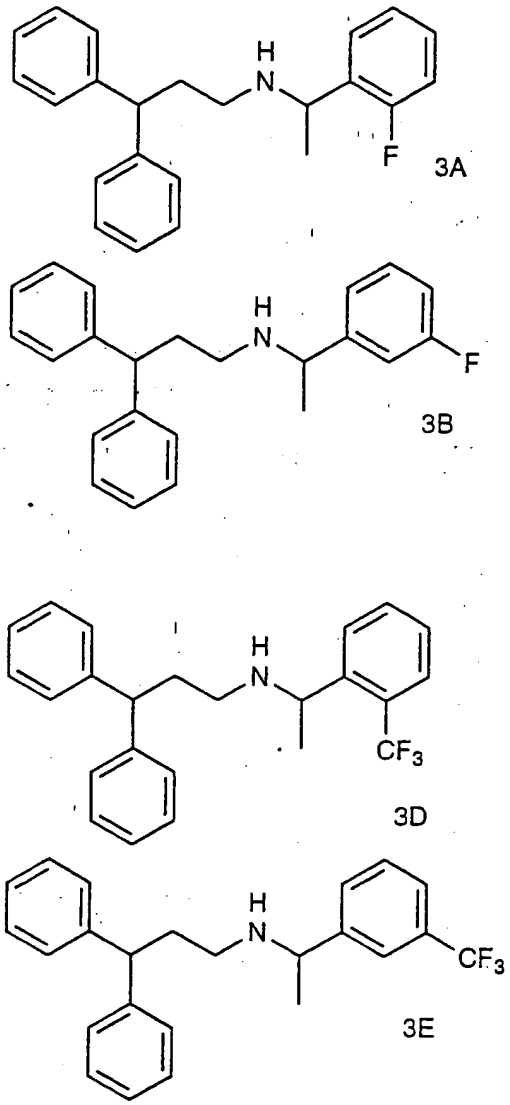


FIG. 3A.

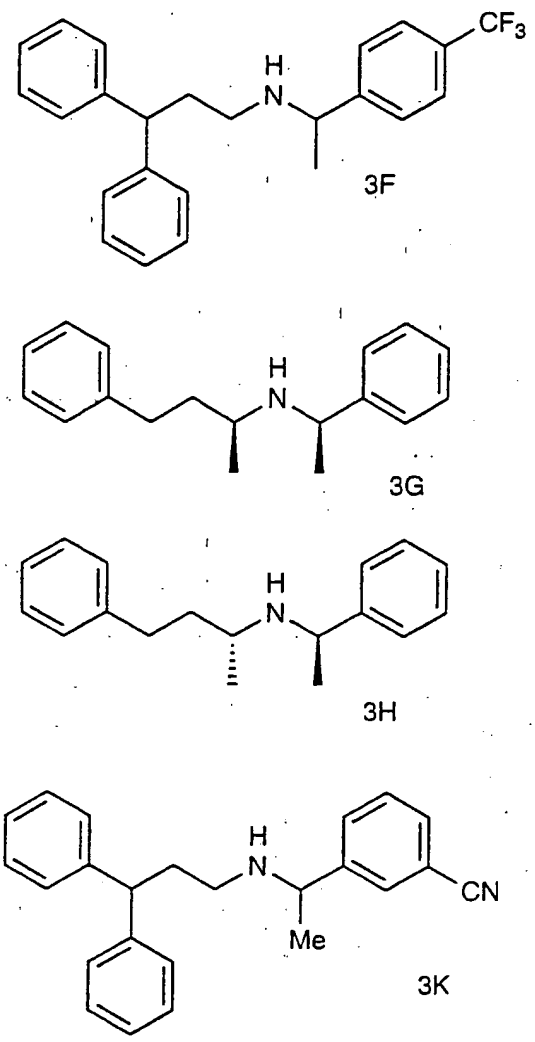
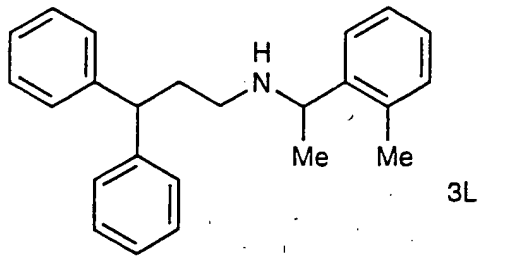
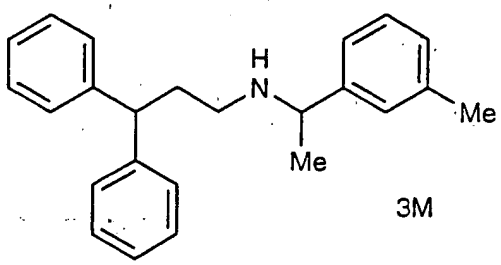


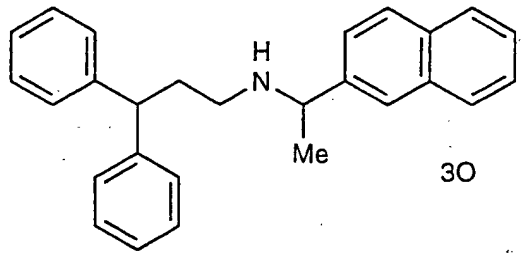
FIG. 3B.



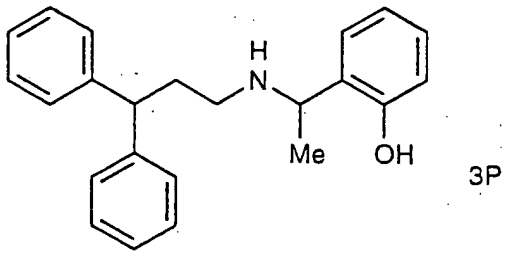
3L



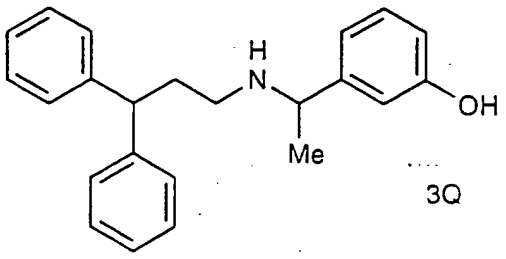
3M



3O



3P



3Q

FIG. 3C.

RECTIFIED SHEET (RULE 91)
ISA / EP

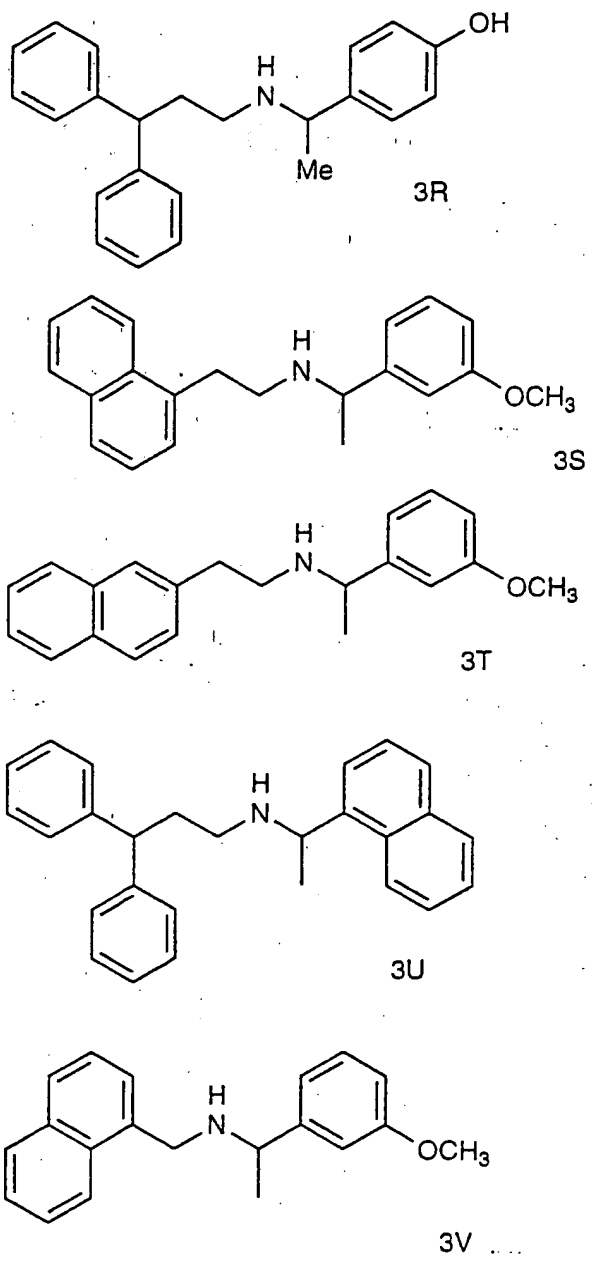
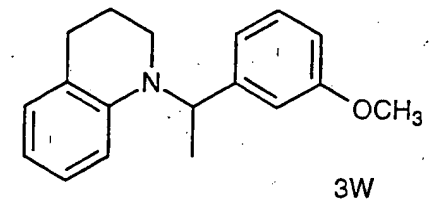
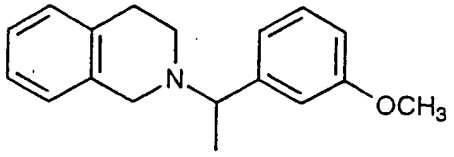


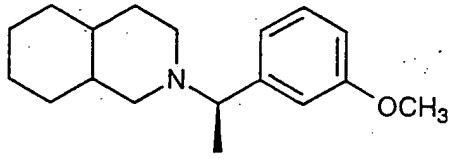
FIG. 3D.



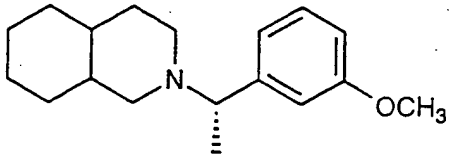
3W



3X

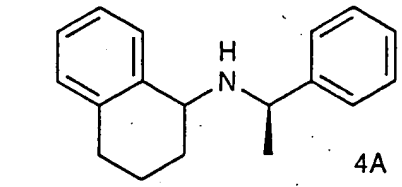


3Y

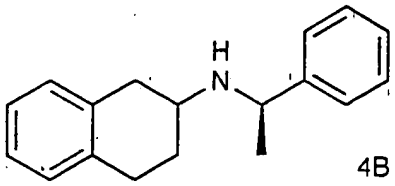


3Z

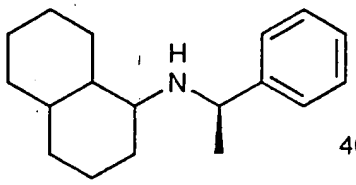
FIG. 3E.



4A



4B



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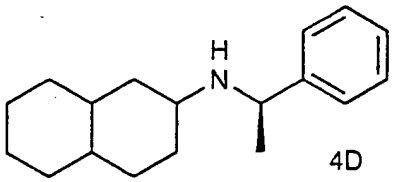

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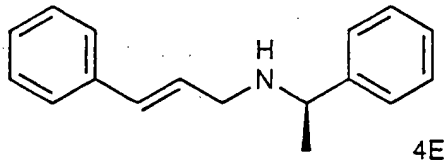

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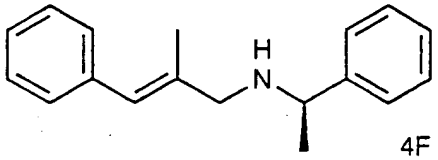
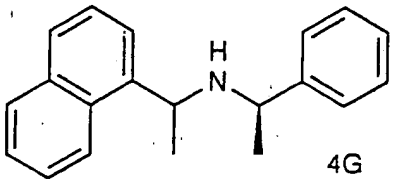


4F

FIG. 4A.



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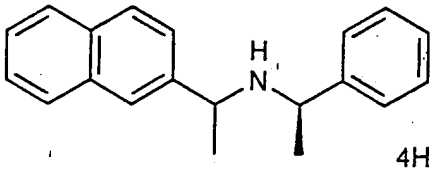
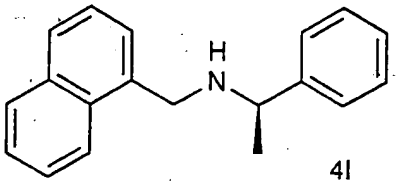
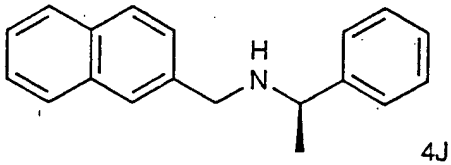


4H



4I



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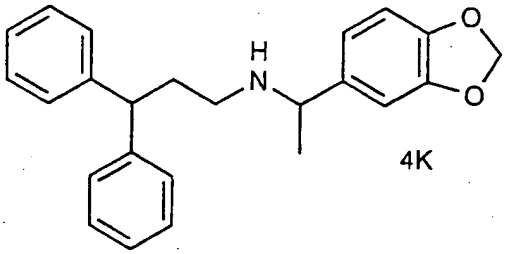

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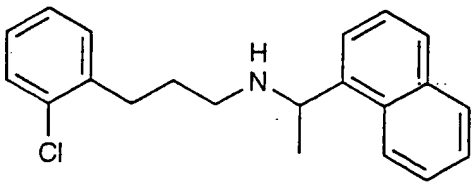
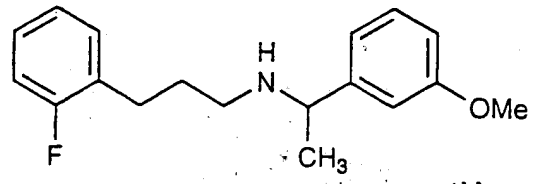
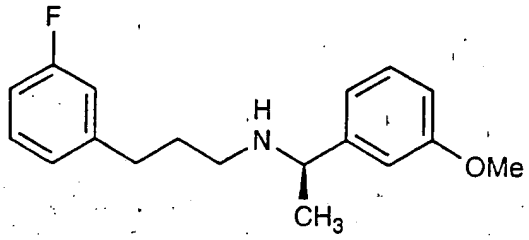


4L

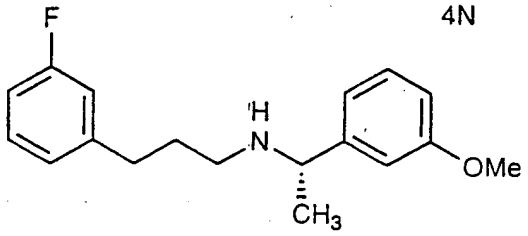
FIG. 4B.



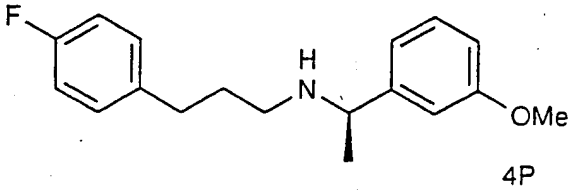
4M



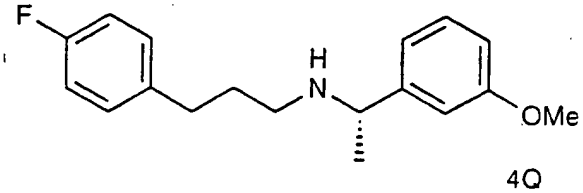
4N



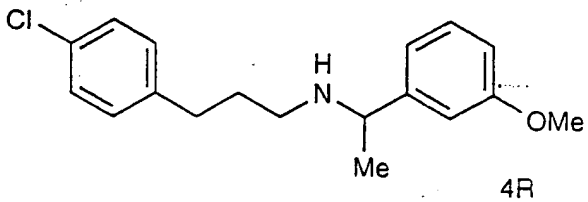
4O



4P



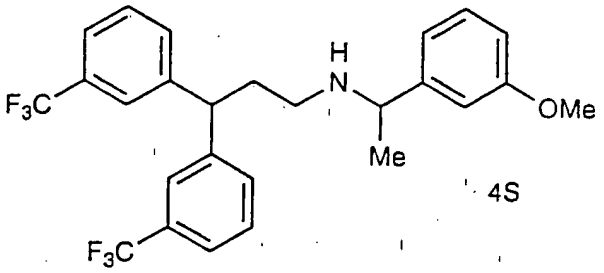
4Q



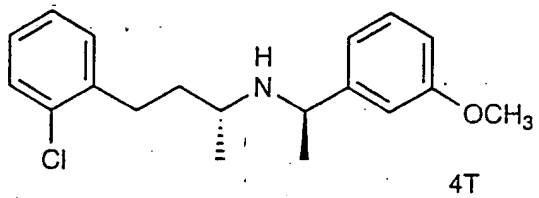
4R

FIG. 4C.

RECTIFIED SHEET (RULE 91)
ISA / EP



4S



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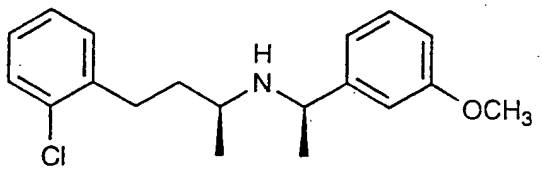
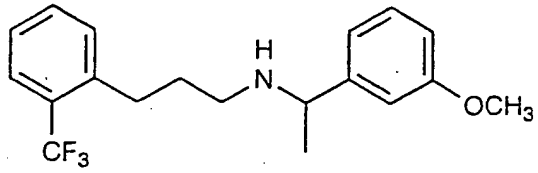
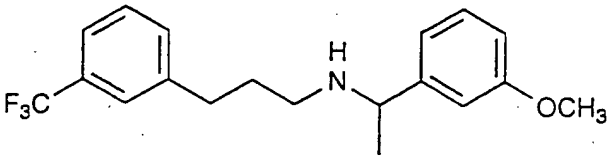


4U



4V



4W

FIG. 4D.

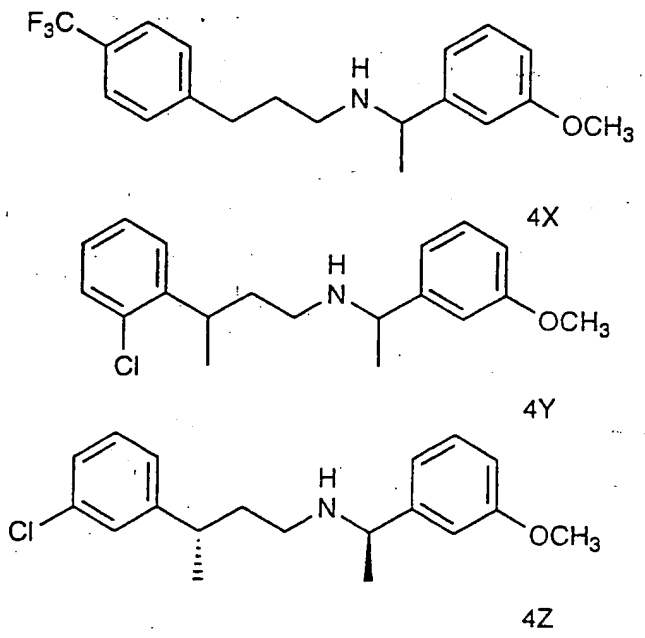


FIG. 4E.

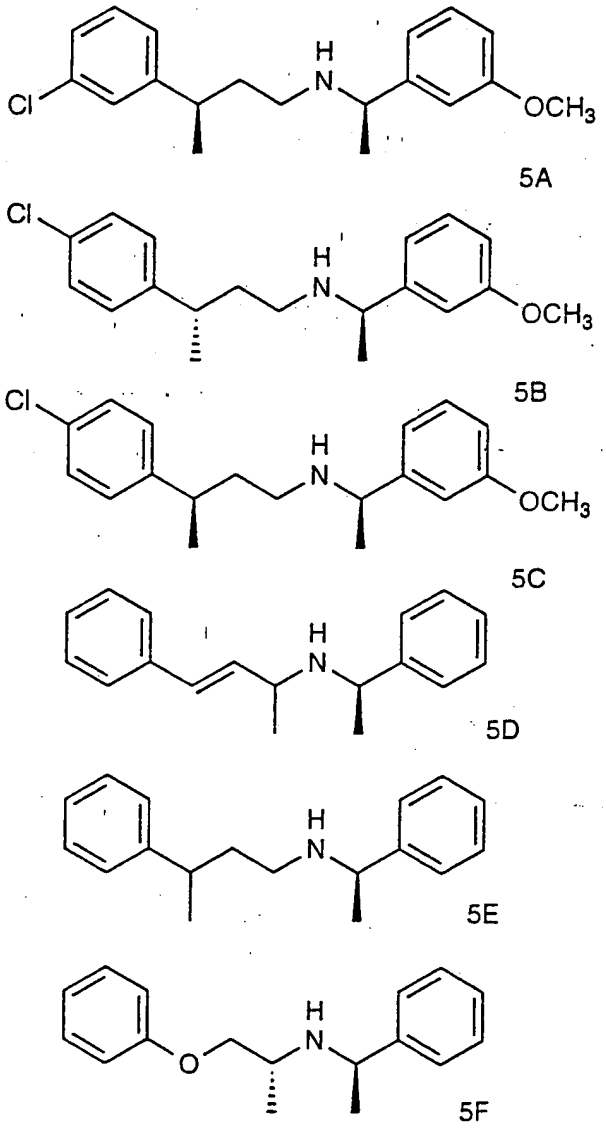
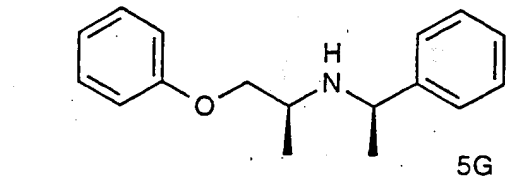
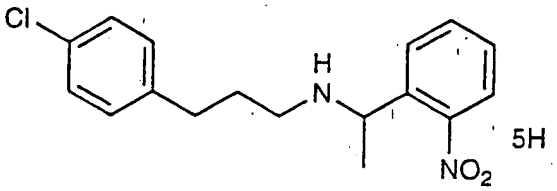


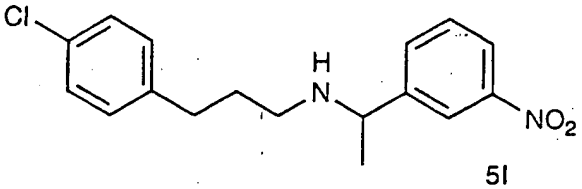
FIG. 5A.



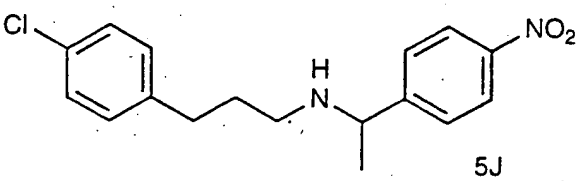
5G



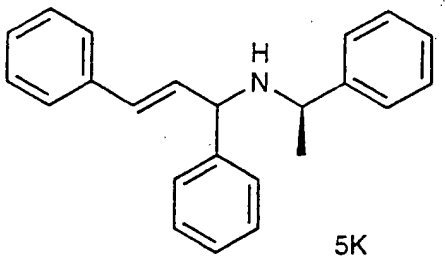
5H



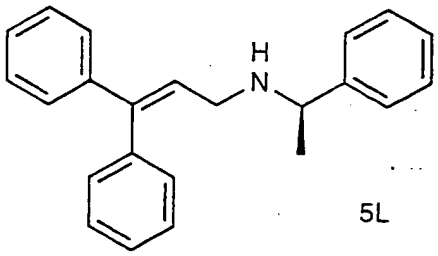
5I



5J

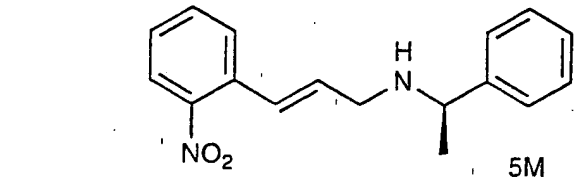


5K

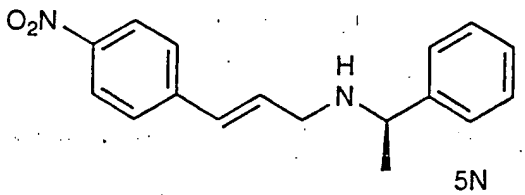


5L

FIG. 5B.



5M



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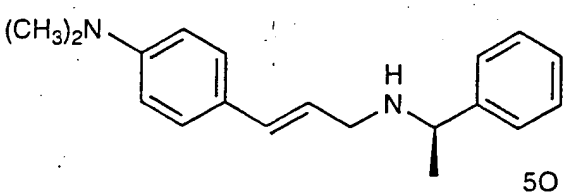

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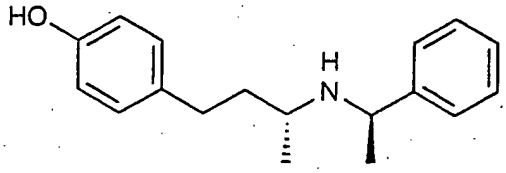
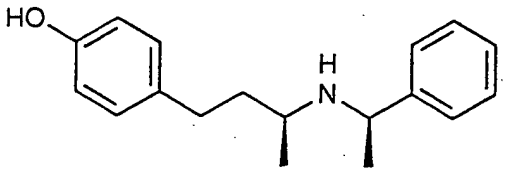


5P



5Q

FIG. 5C.

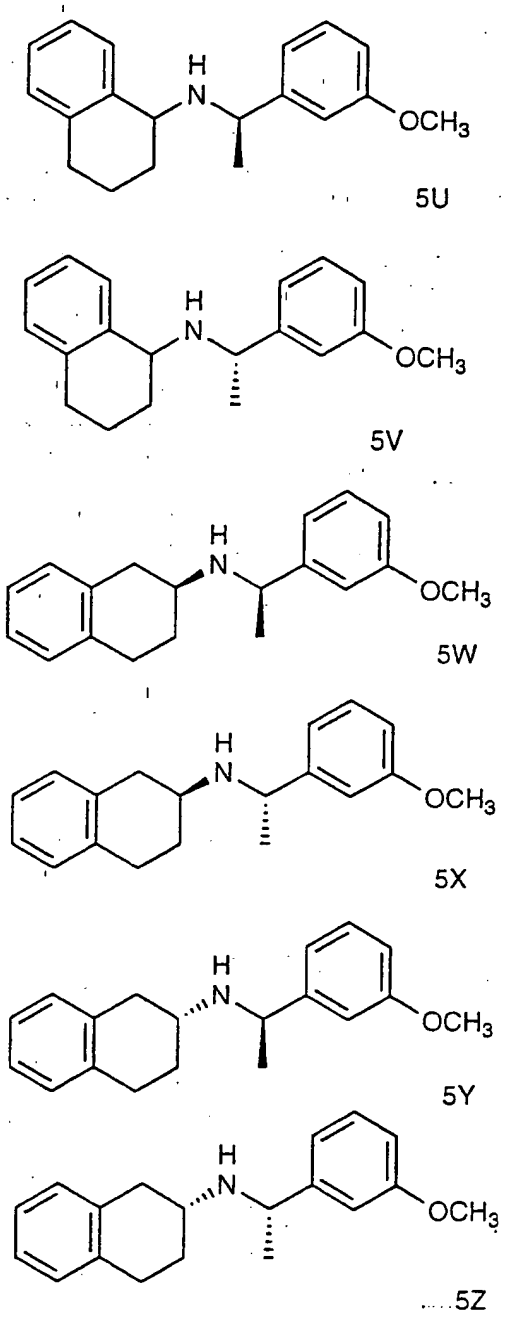


FIG. 5D.

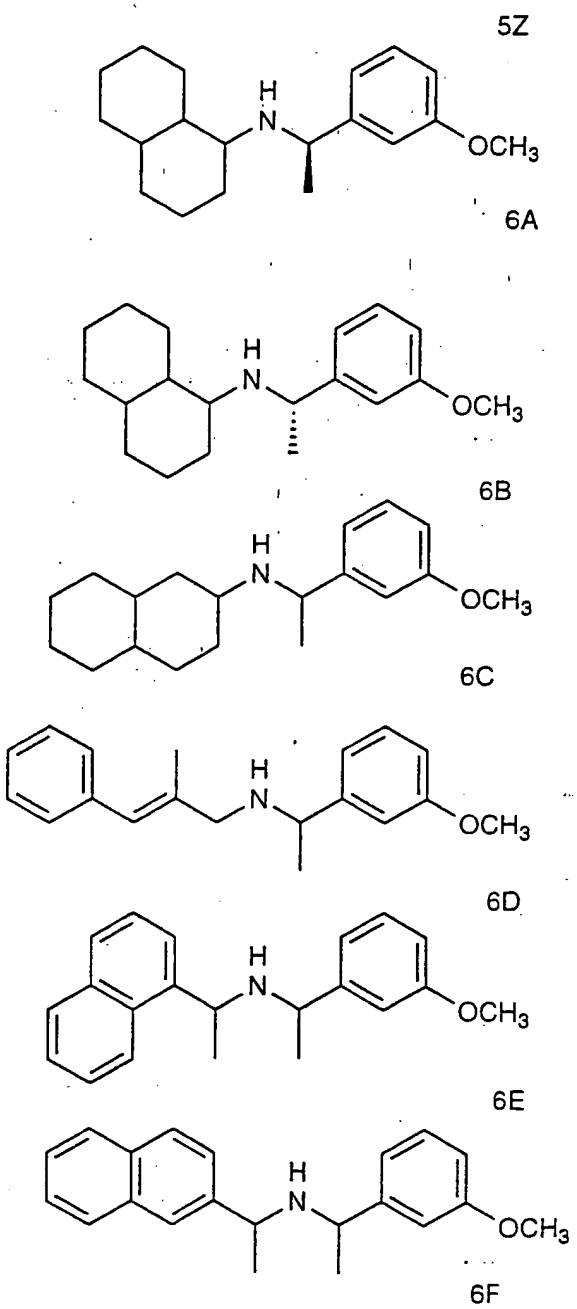
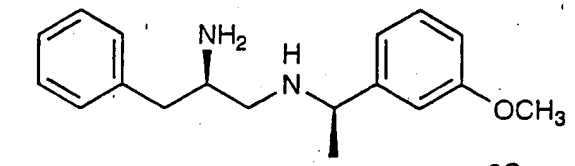
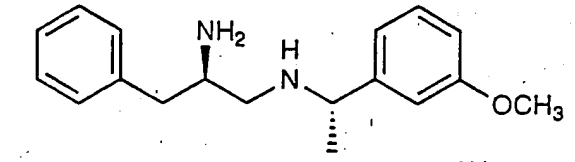


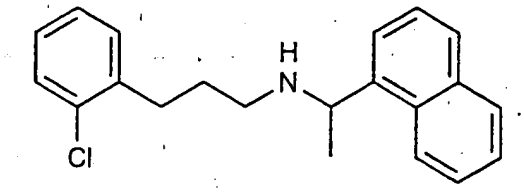
FIG. 6A.



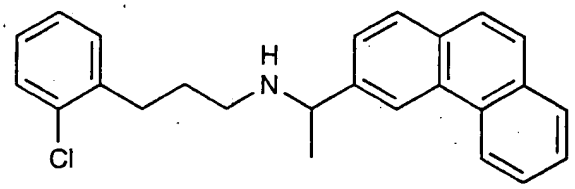
6G



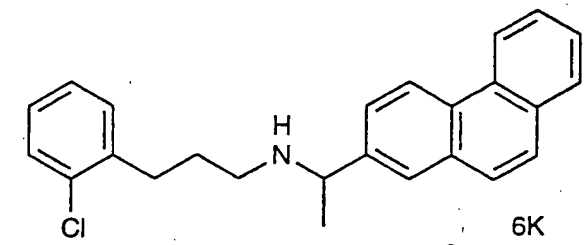
6H



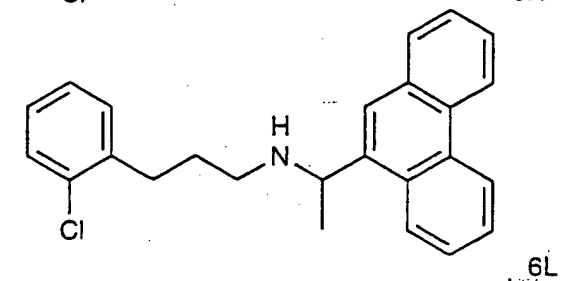
6I



6J



6K



6L

FIG. 6B.

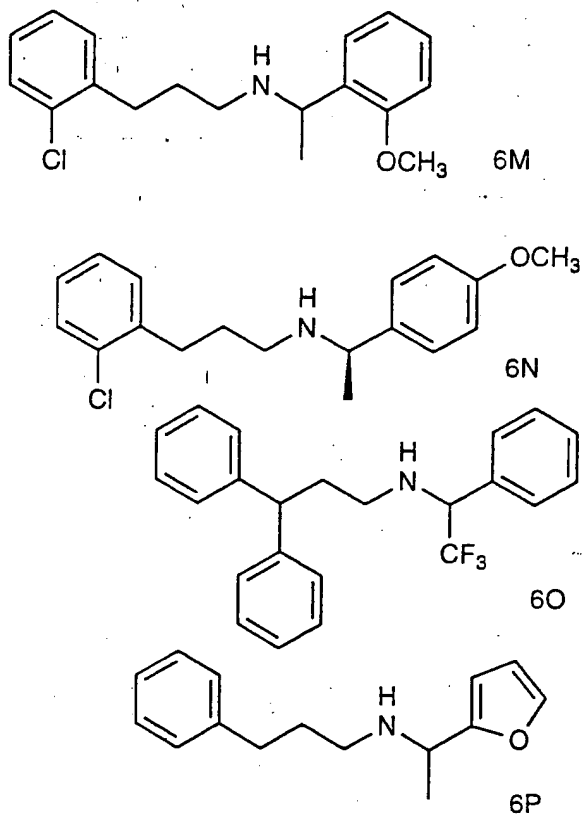


FIG. 6C.

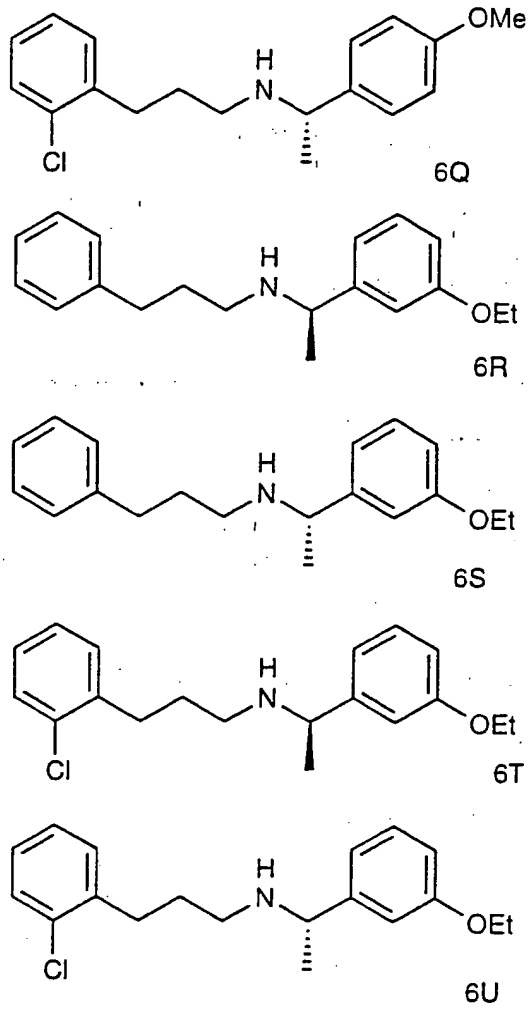


FIG. 6D.

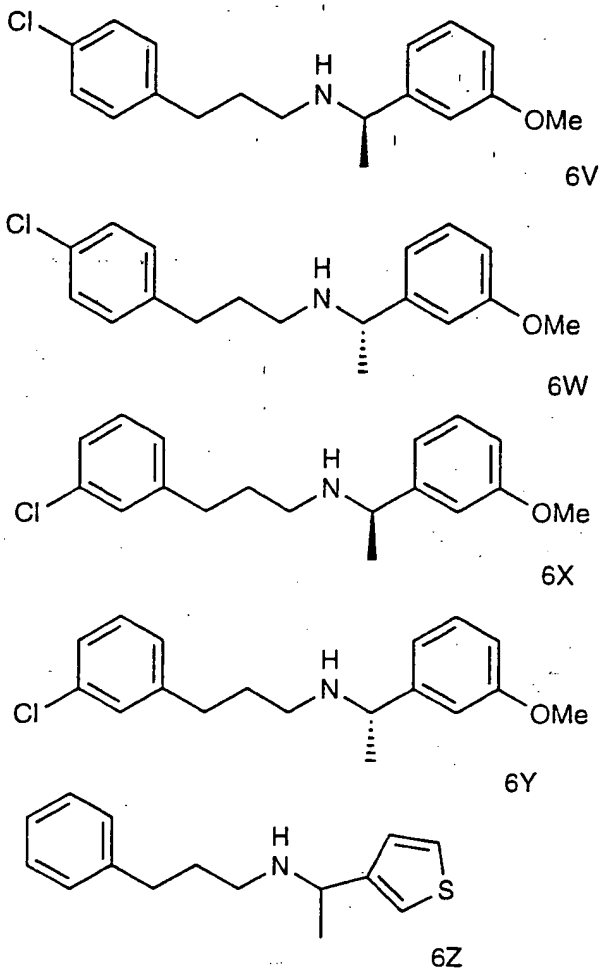


FIG. 6E.

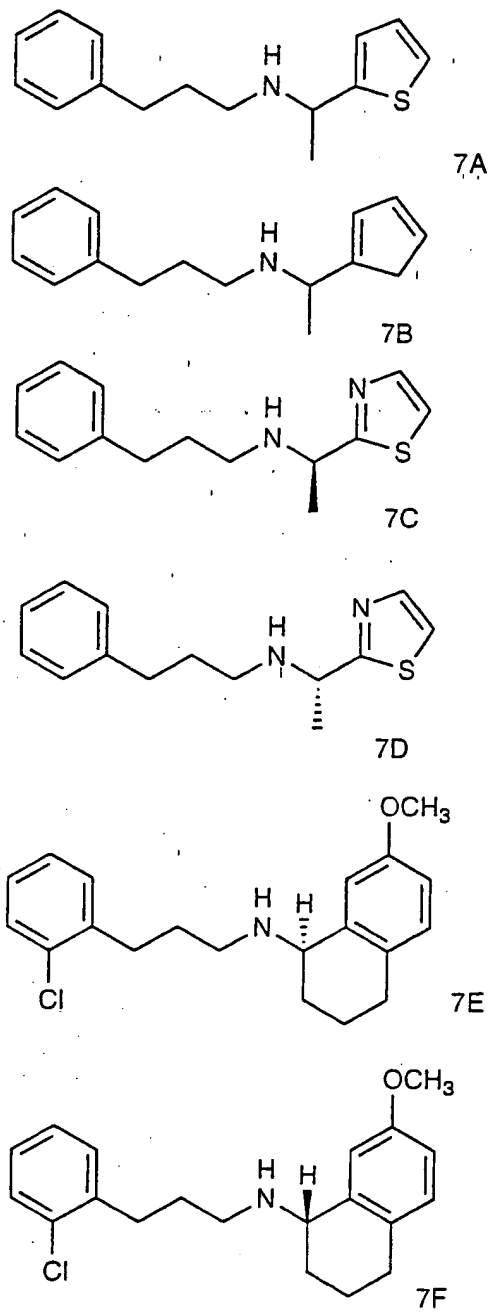
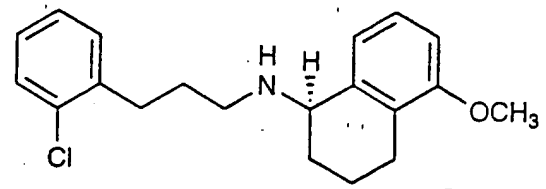
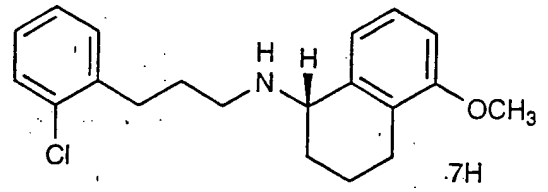


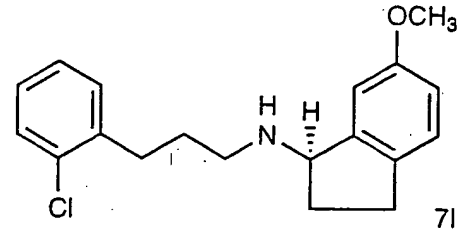
FIG. 7A.



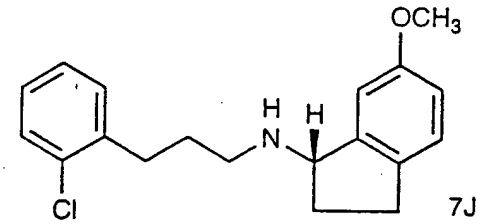
7G



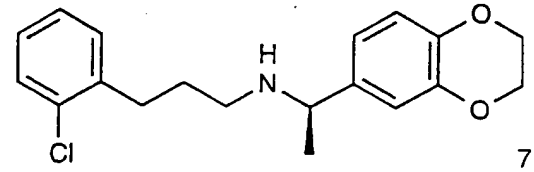
7H



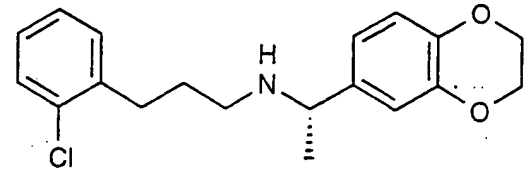
7I



7J



7K



7L

FIG. 7B.

RECTIFIED SHEET (RULE 91)
ISA / EP

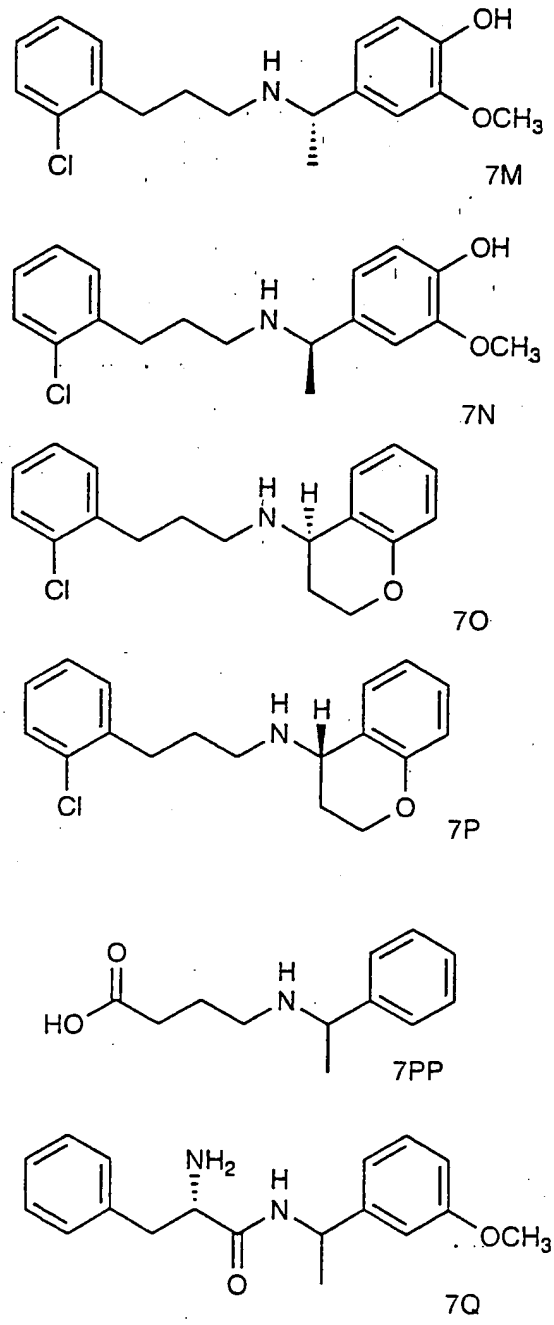


FIG. 7C.

RECTIFIED SHEET (RULE 91)
ISA / EP

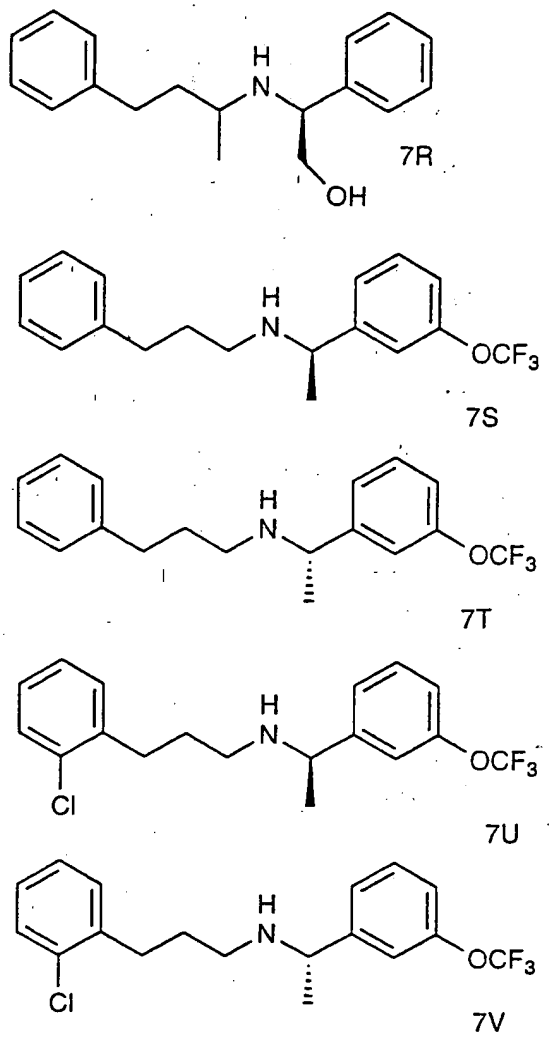


FIG. 7D.

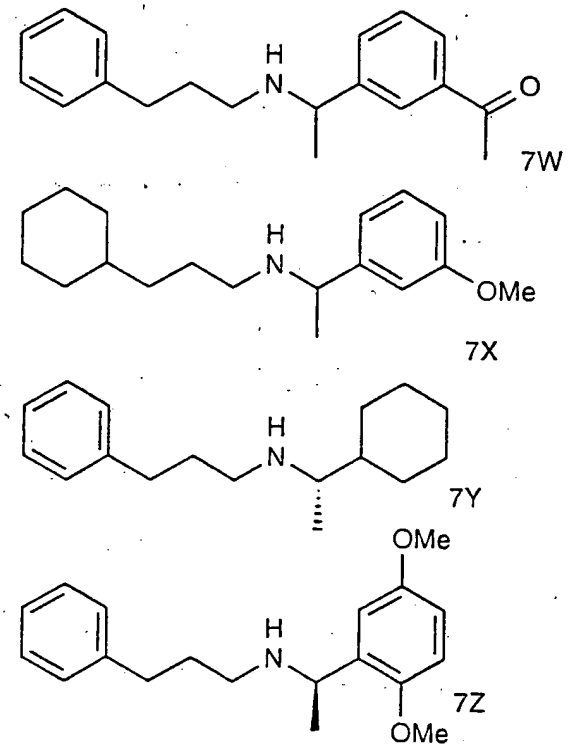


FIG. 7E.

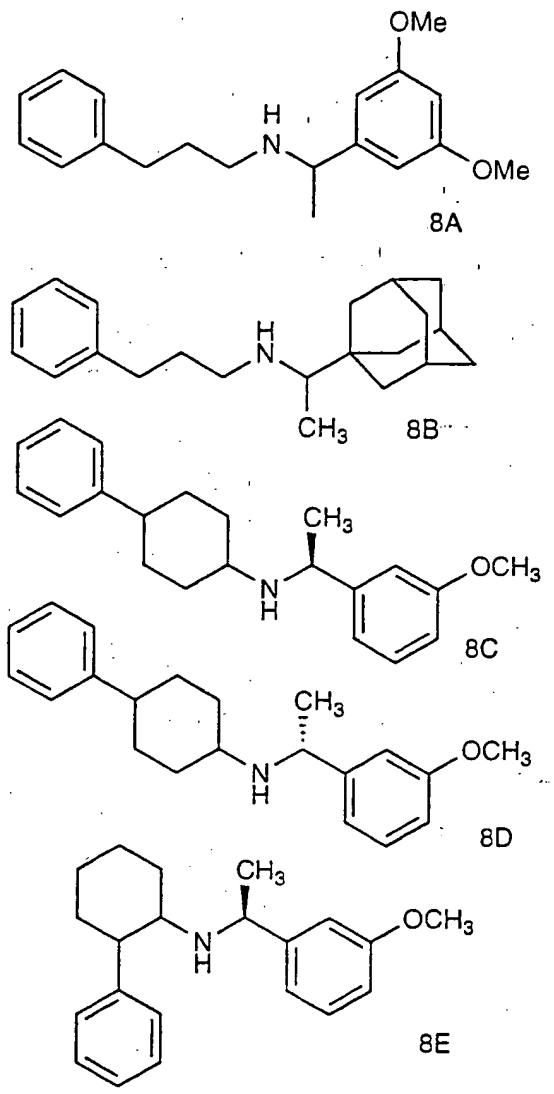


FIG. 8A.

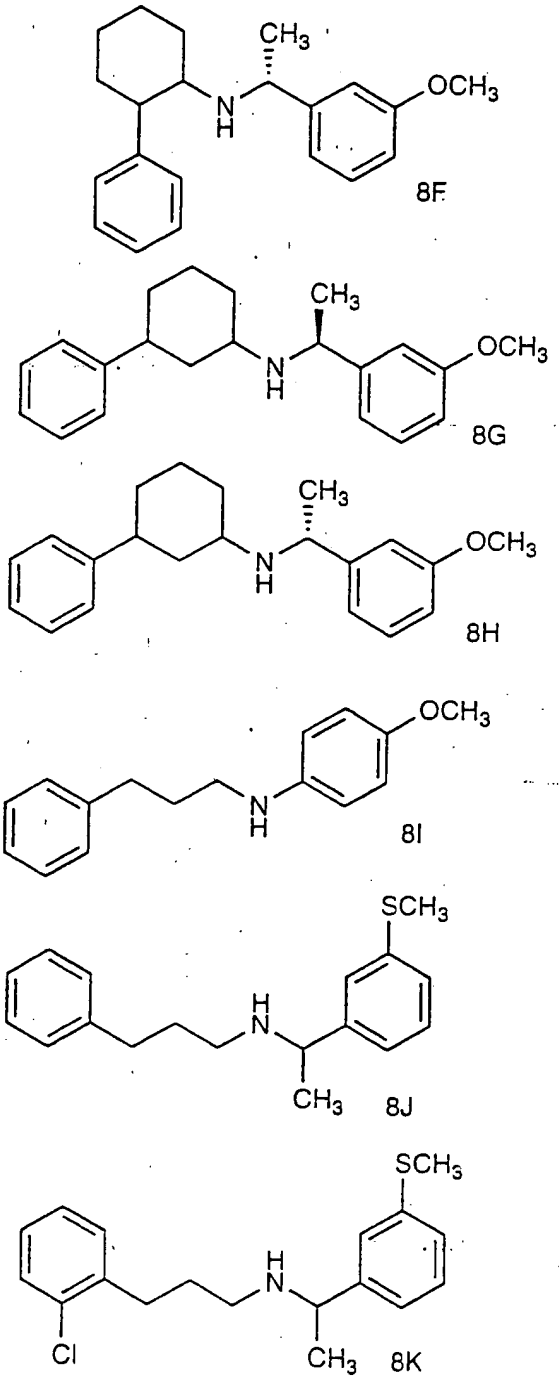


FIG. 8B.

RECTIFIED SHEET (RULE 91)
ISA / EP

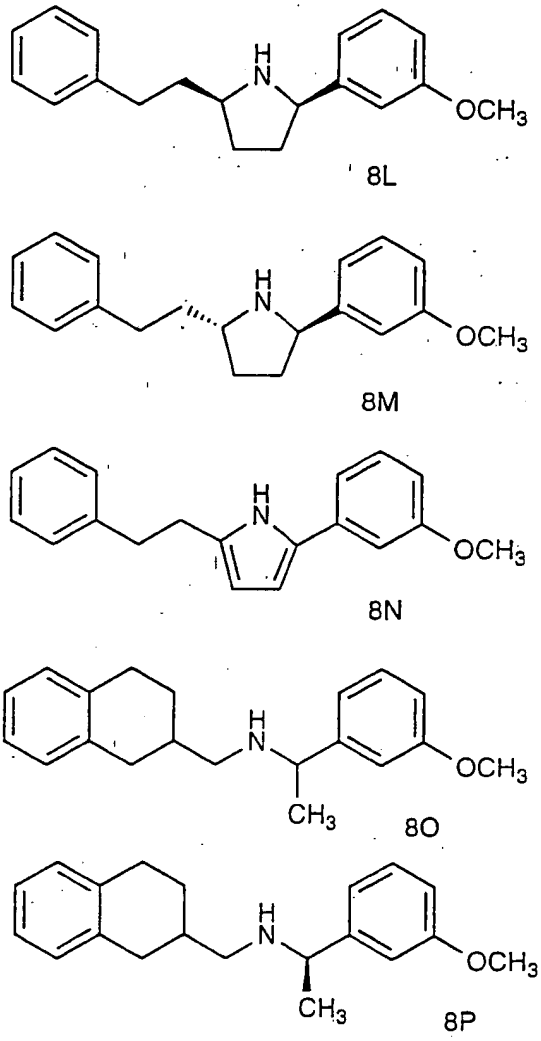


FIG. 8C.

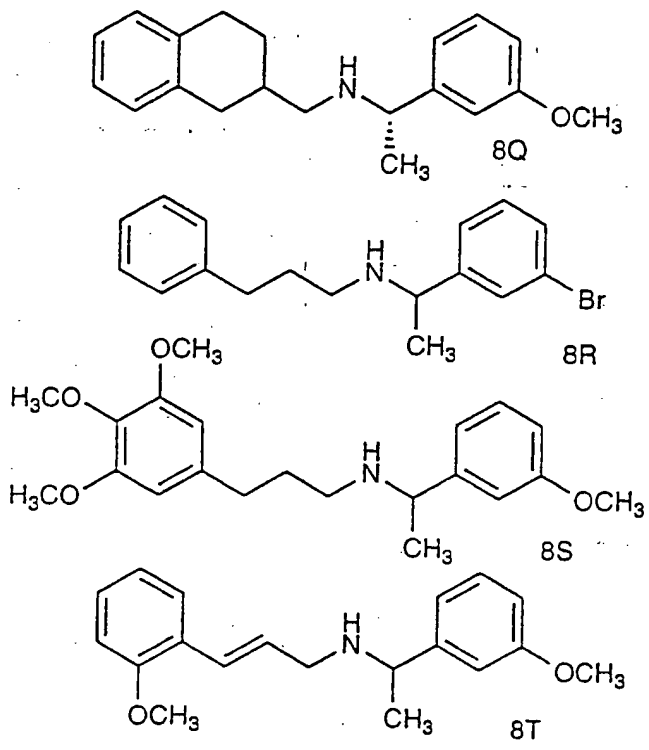


FIG. 8D.

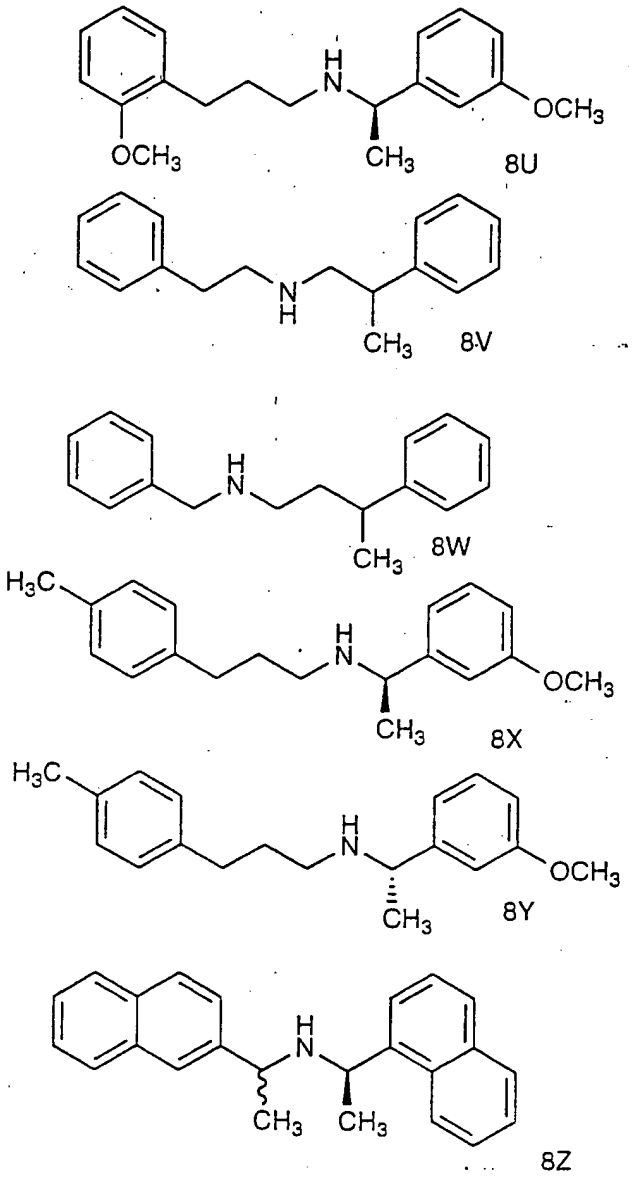


FIG. 8E.

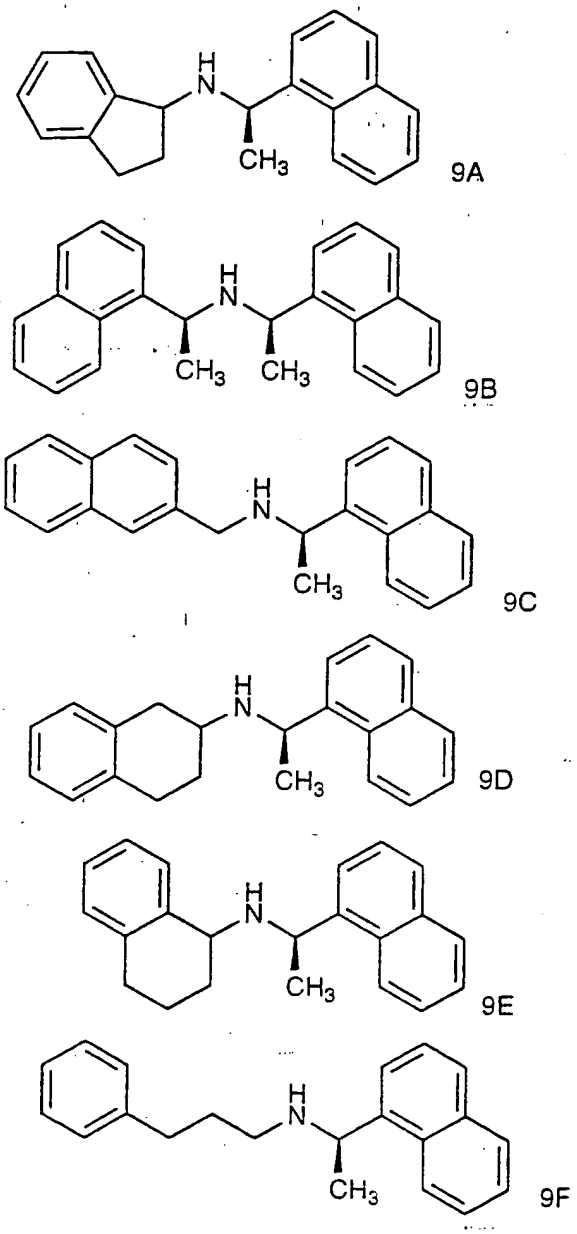


FIG. 9A.

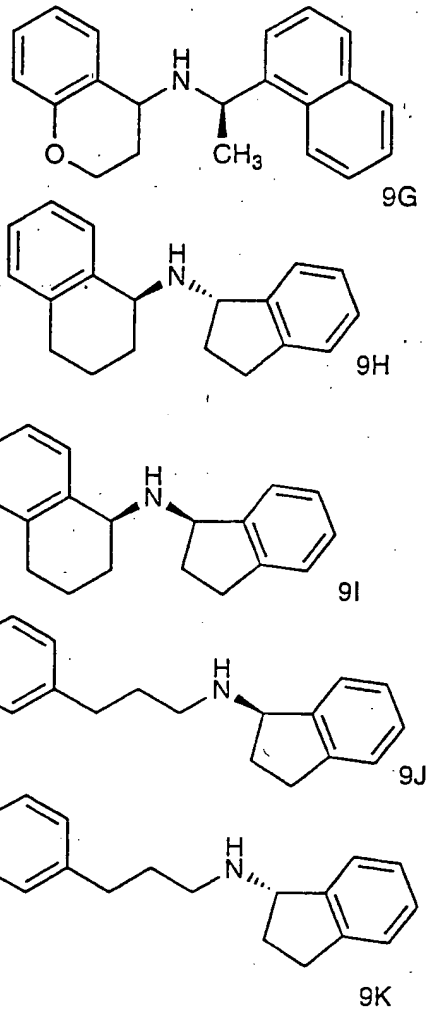


FIG. 9B.

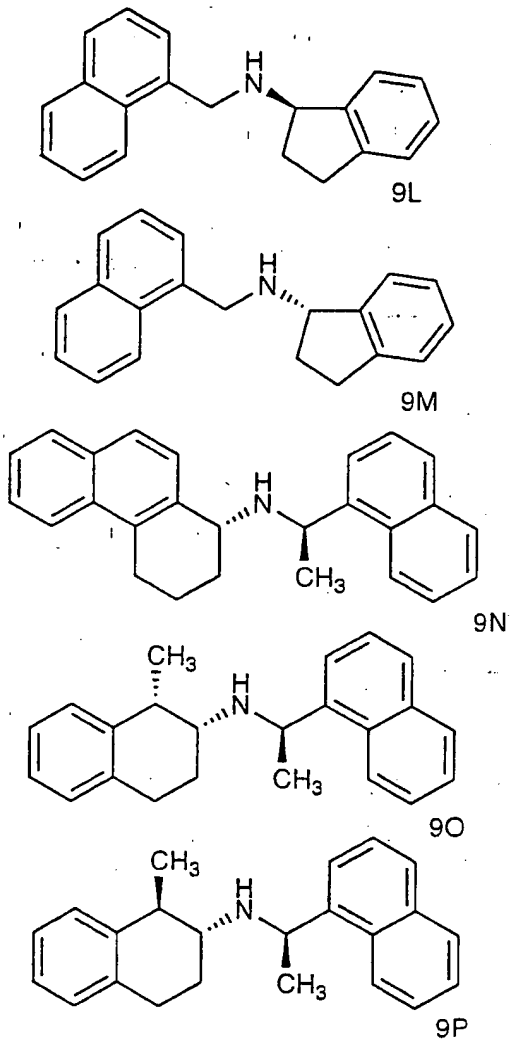


FIG. 9C.

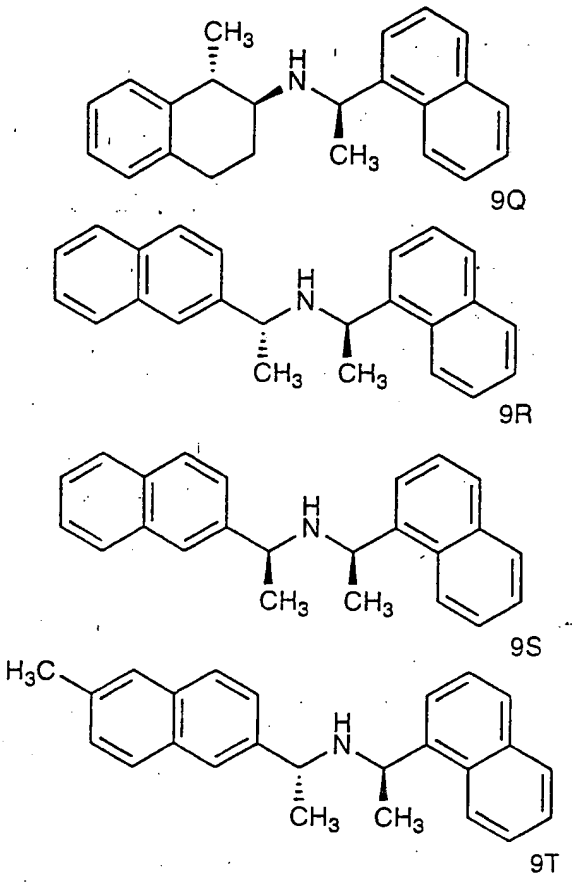


FIG. 9D.

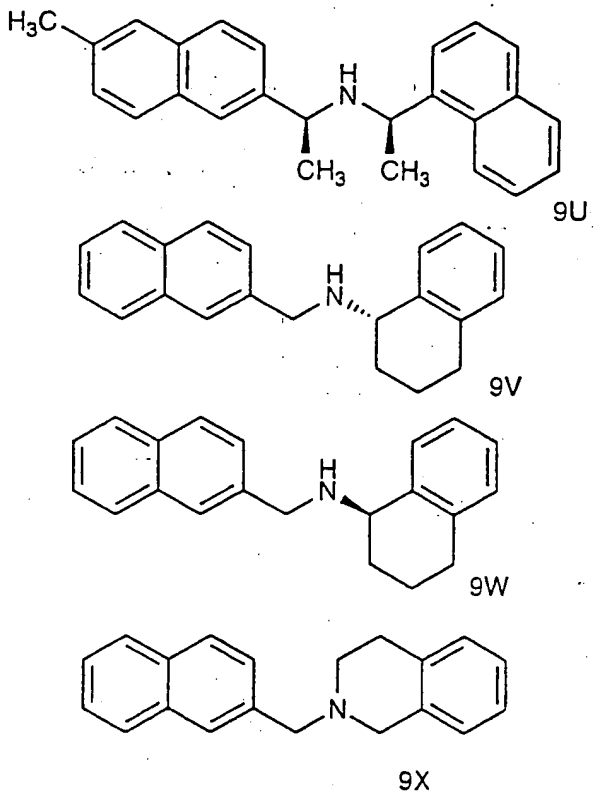
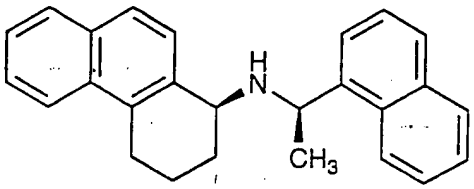
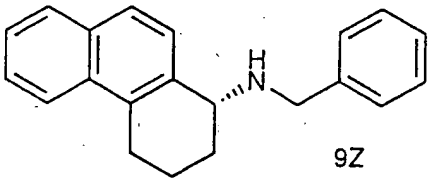


FIG. 9E.

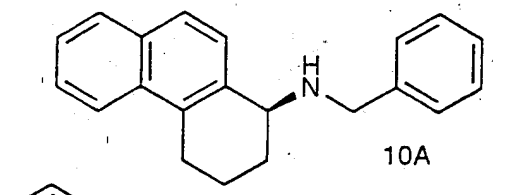


9Y

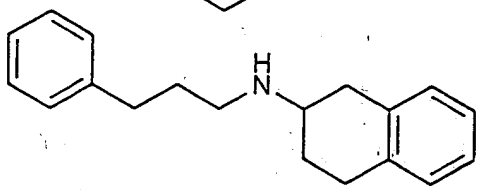


9Z

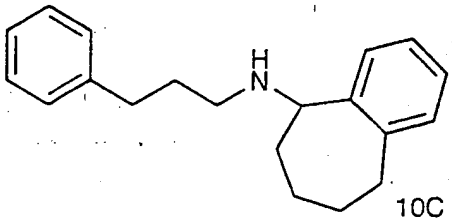
FIG. 9F.



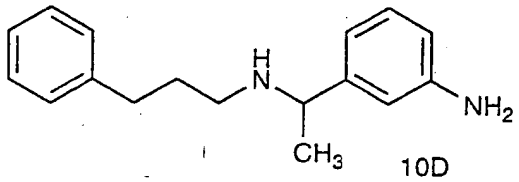
10A



10B



10C



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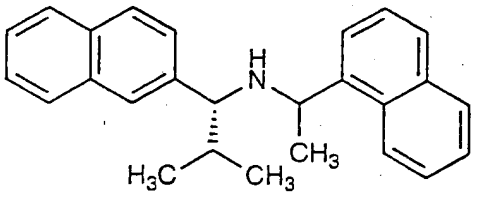
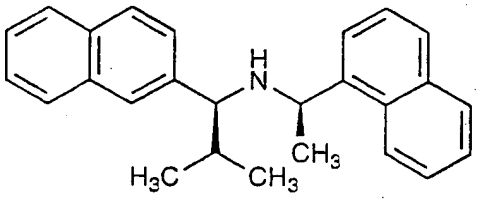


10E



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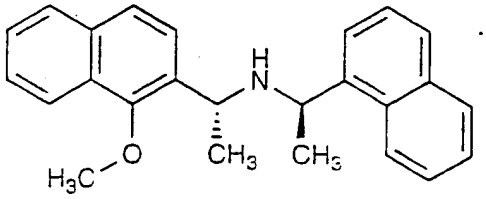
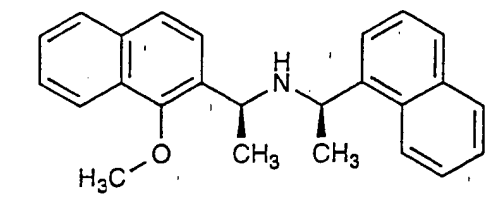


10G

FIG. 10A.



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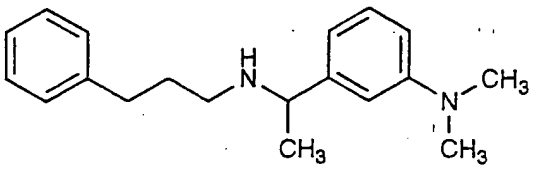

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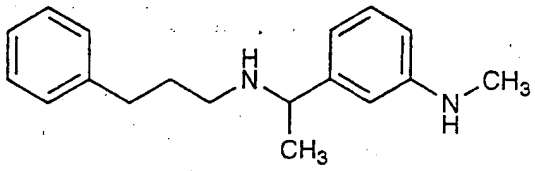
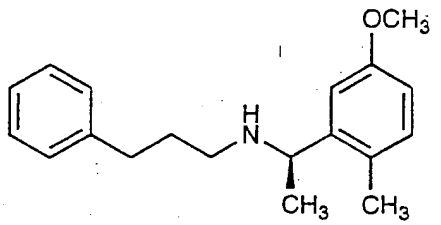


10J



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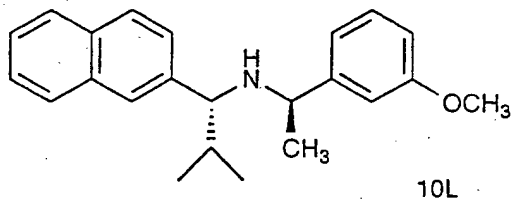
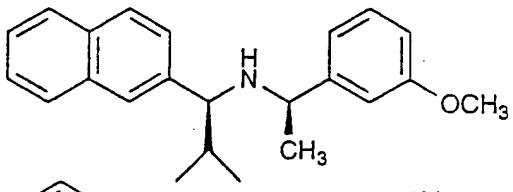
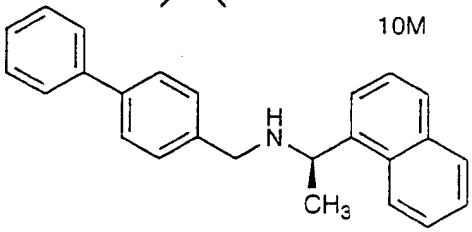


10L

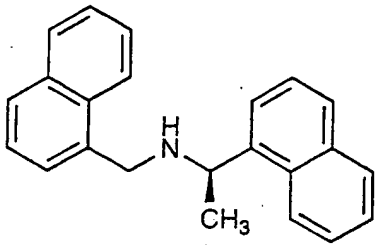


10M

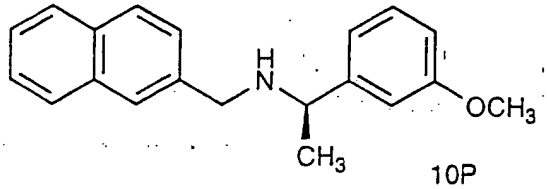


10N

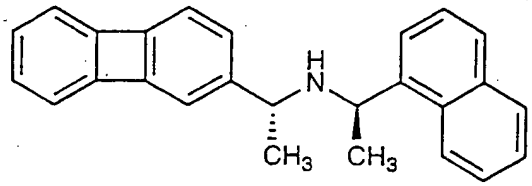
FIG. 10B.



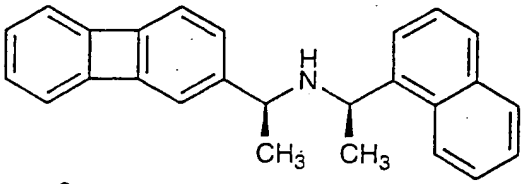
10O



10P



10Q



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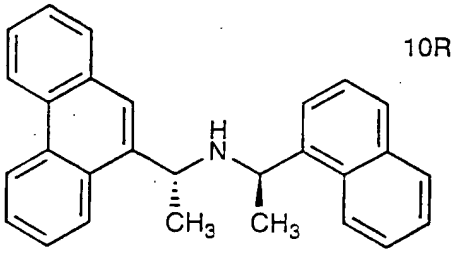

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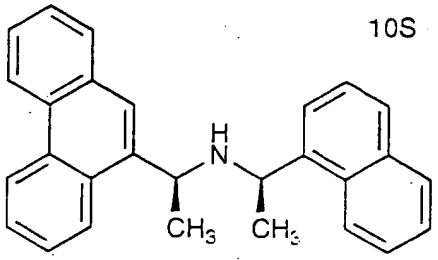
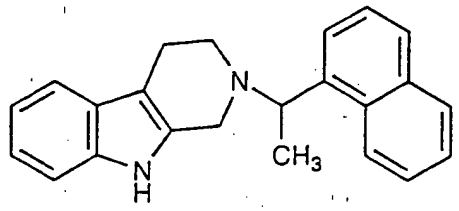


10T

FIG.10C.



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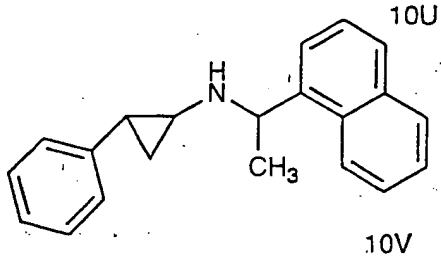
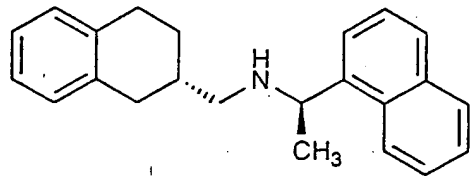
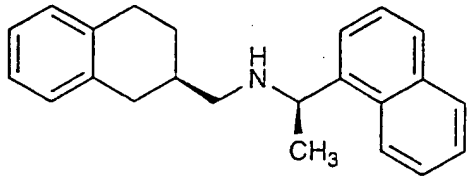


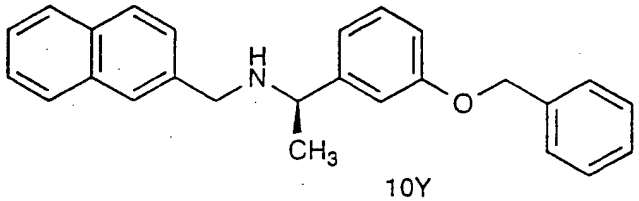
10V



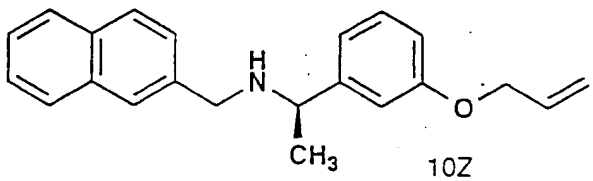
10W



10X

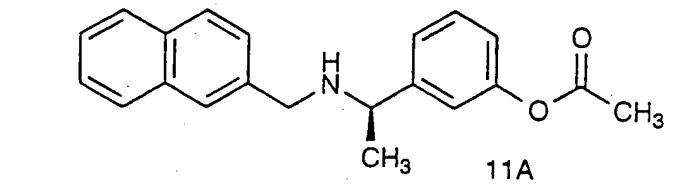


10Y

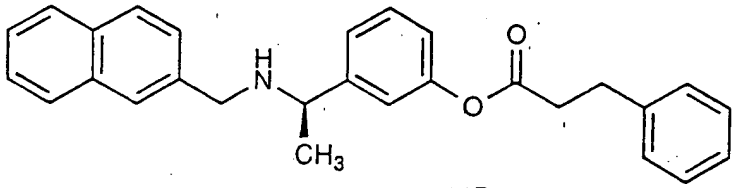


10Z

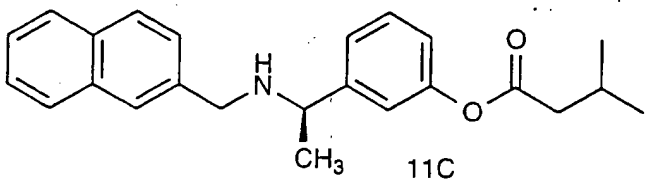
FIG. 10D.



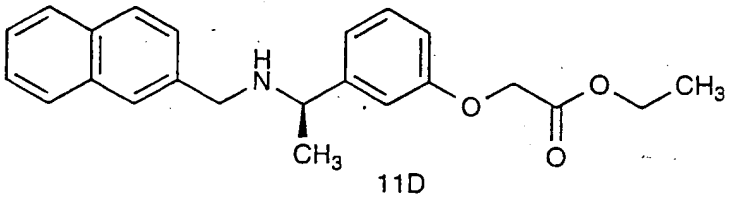
11A



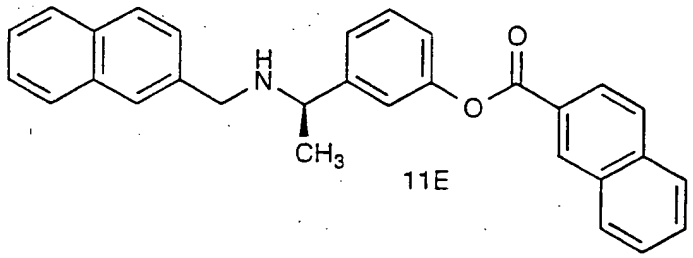
11B



11C



11D



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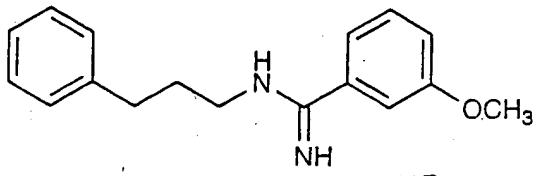
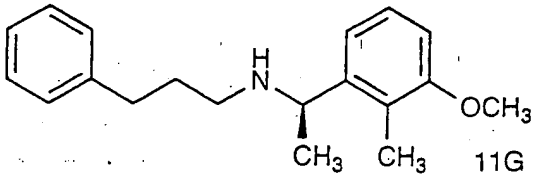
11E

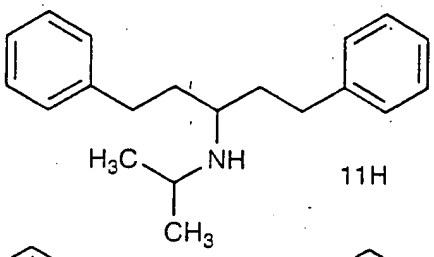
FIG. 11A.



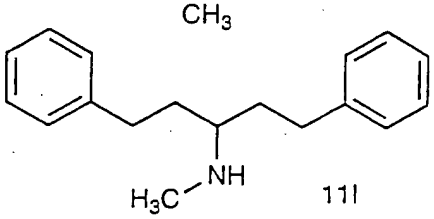
11F



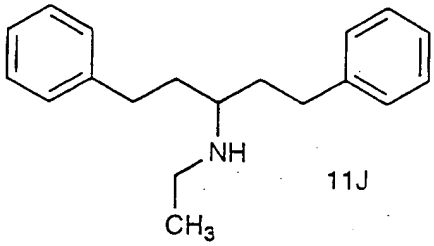
11G



11H

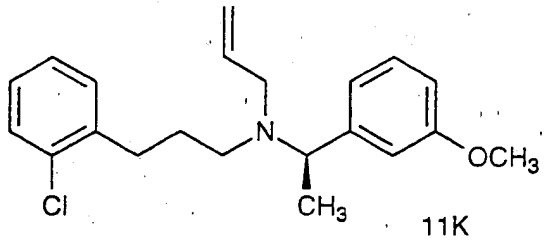


11I

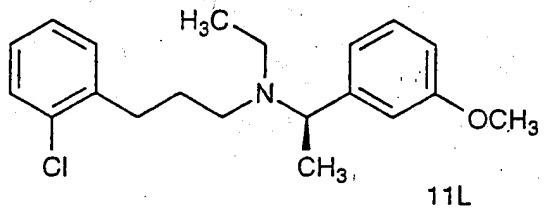


11J

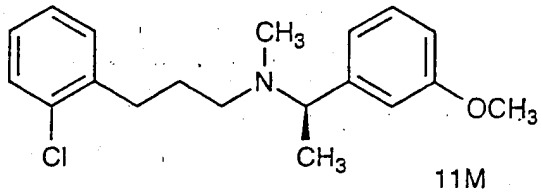
FIG. 11B.



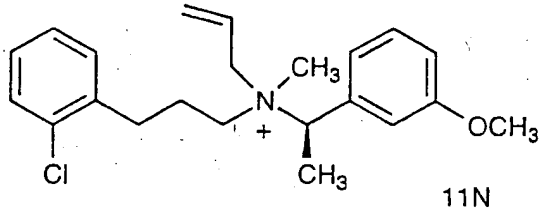
11K



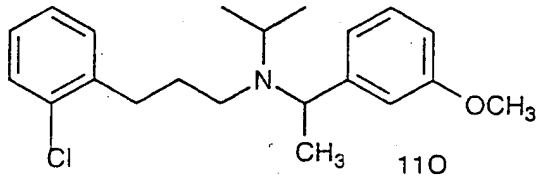
11L



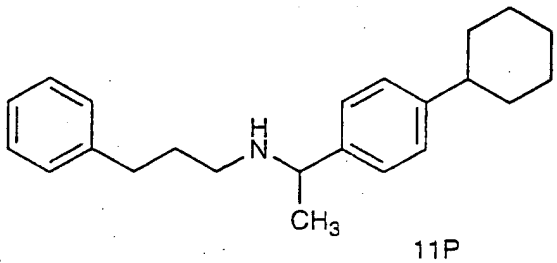
11M



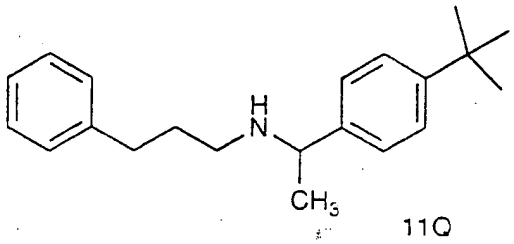
11N



11O



11P



11Q

FIG. 11C.

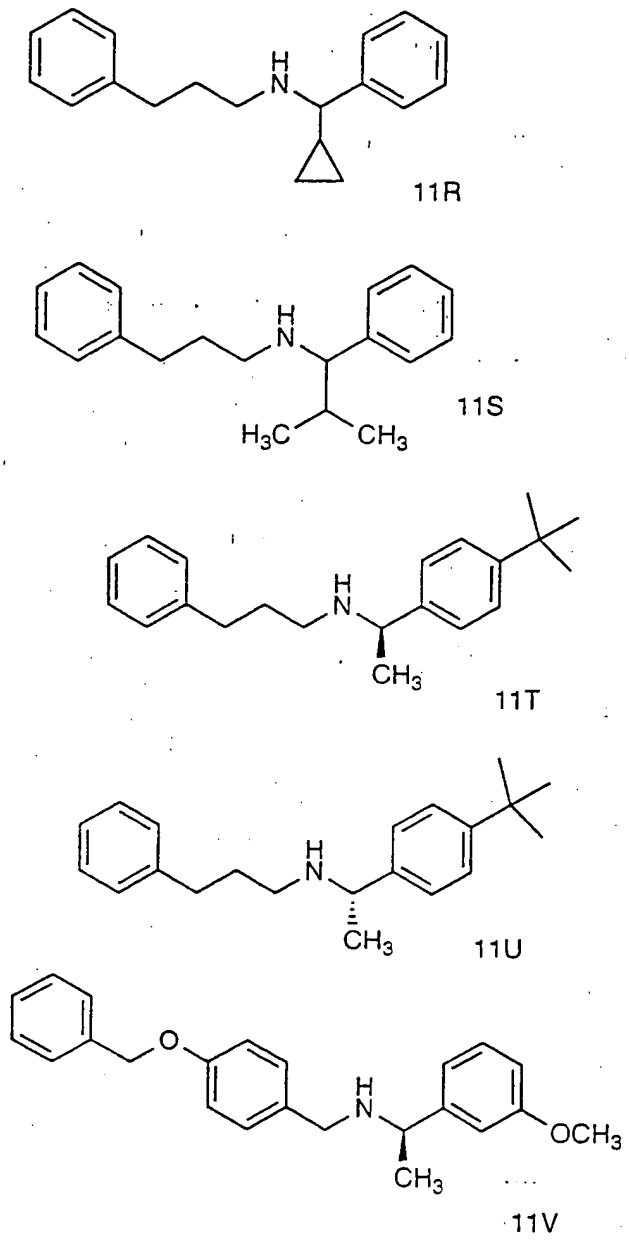
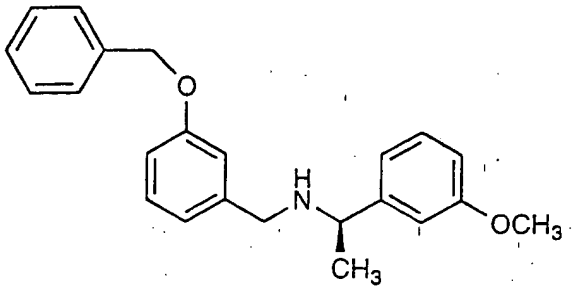
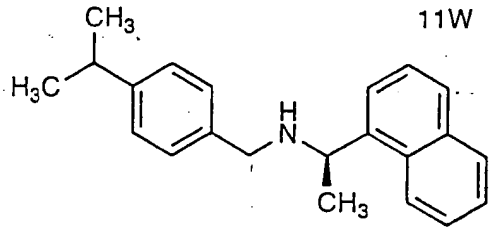


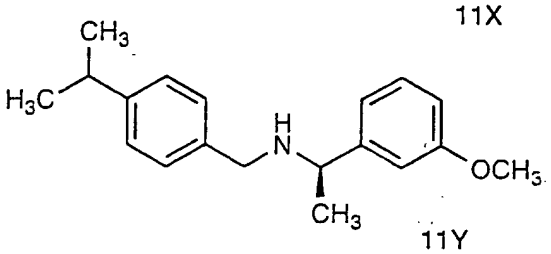
FIG. 11D.



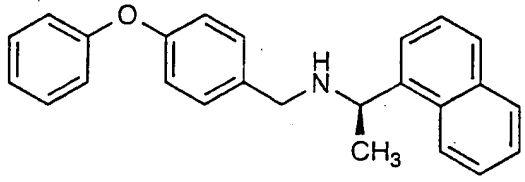
11W



11X

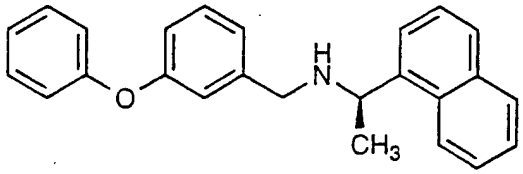


11Y

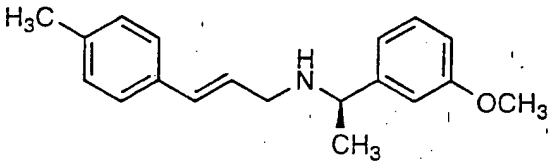


11Z

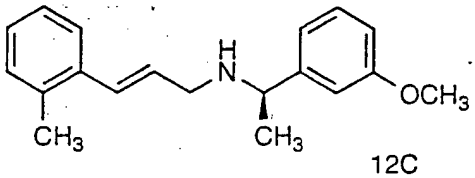
FIG. 11E.



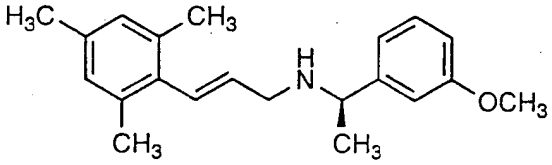
12A



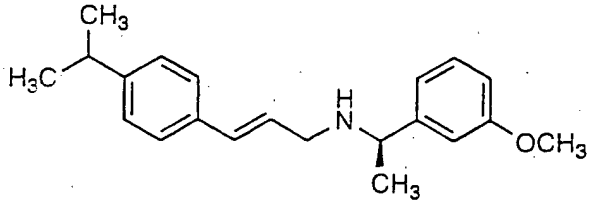
12B



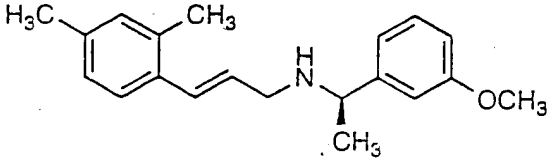
12C



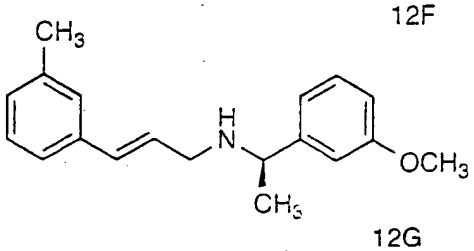
12D



12E

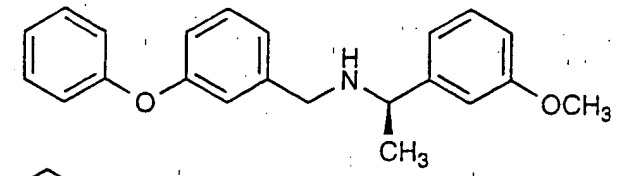


12F

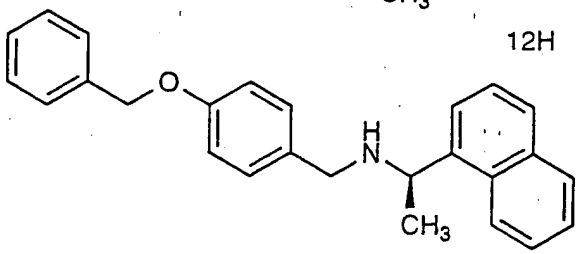


12G

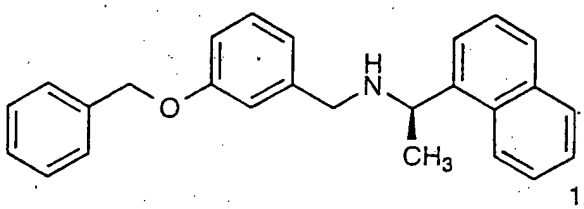
FIG. 12A.



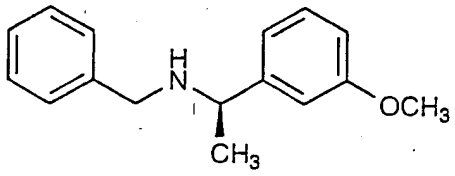
12H



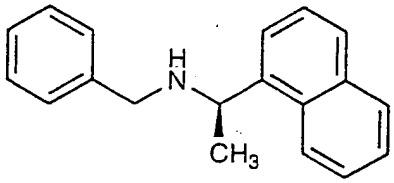
12I



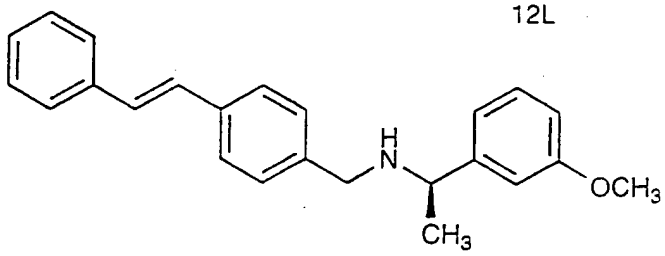
12J



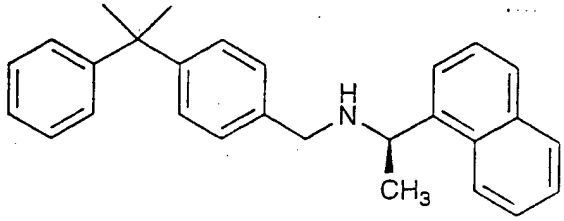
12K



12L

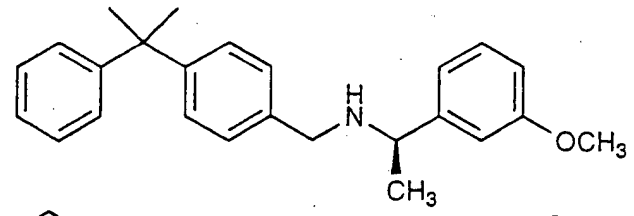


12M

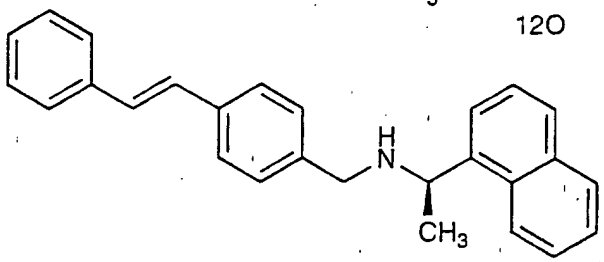


12N

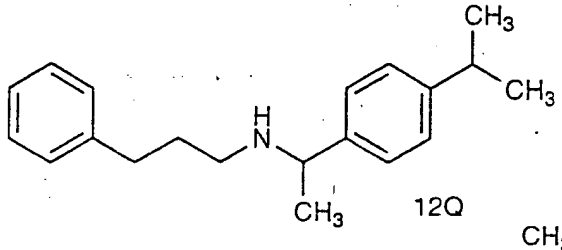
FIG. 12B.



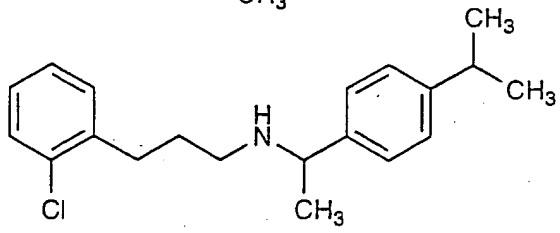
12O



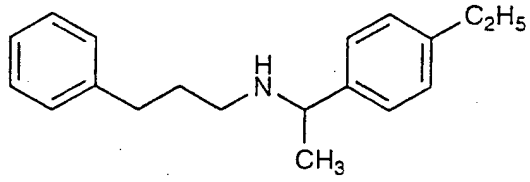
12P



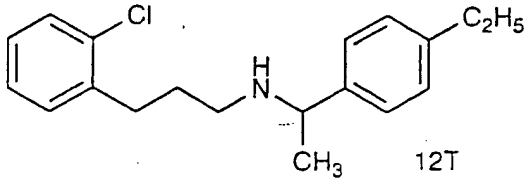
12Q



12R

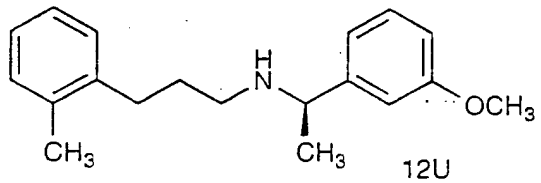


12S

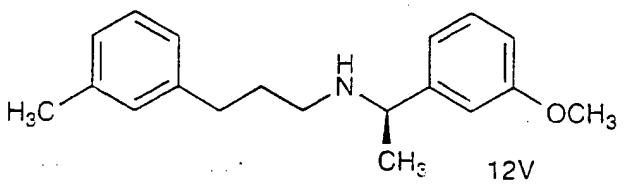


12T

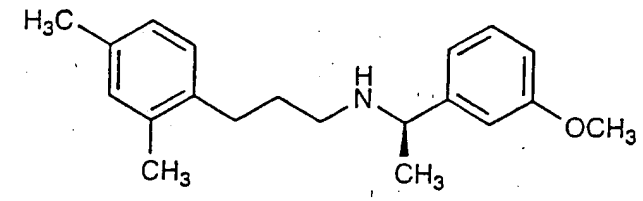
FIG. 12C.



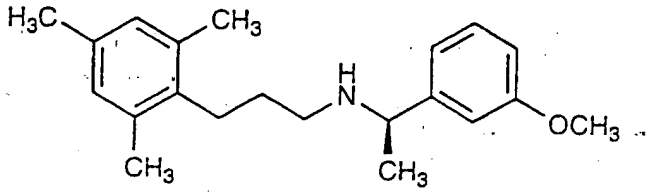
12U



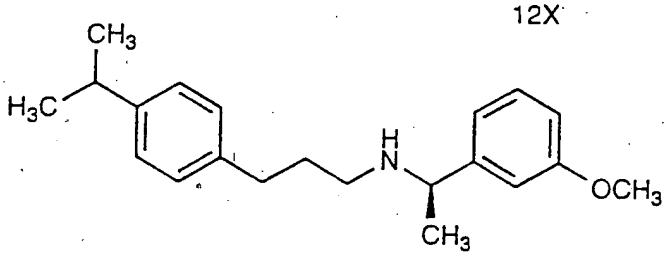
12V



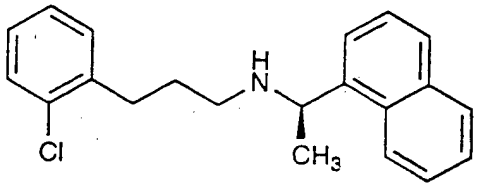
12W



12X



12Y



12Z

FIG. 12D.

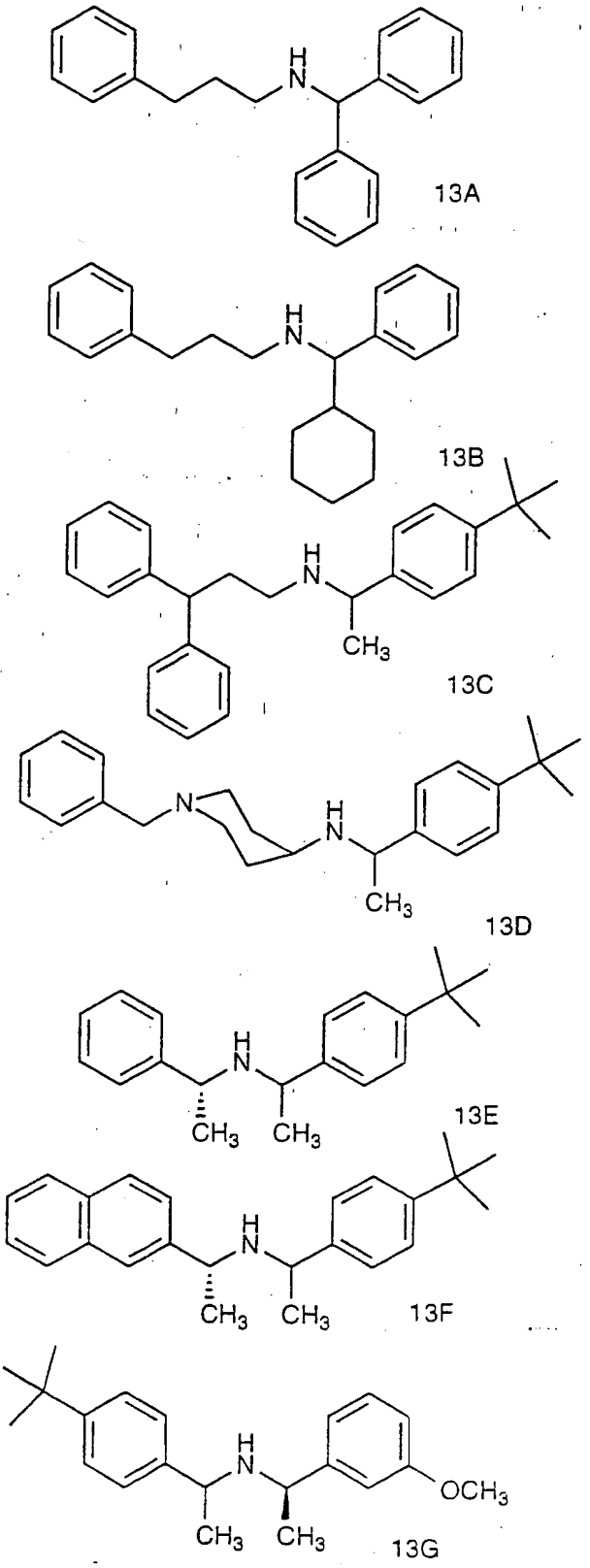
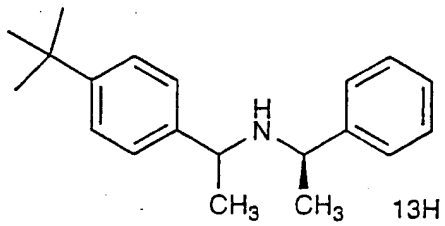
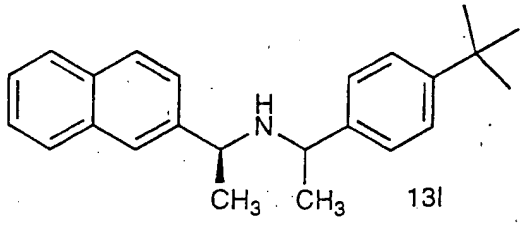


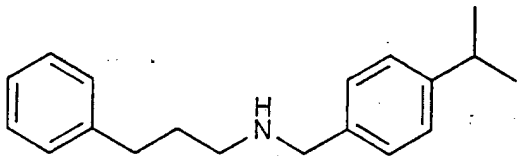
FIG. 13A.



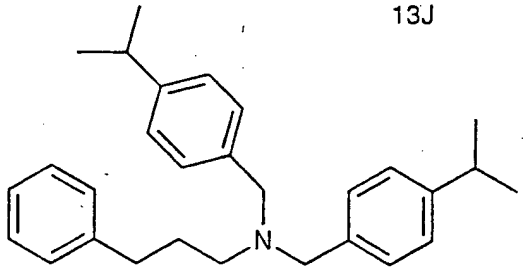
13H



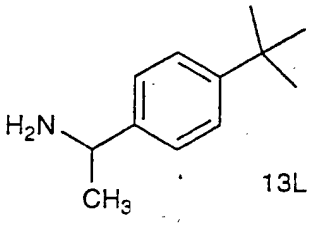
13I



13J

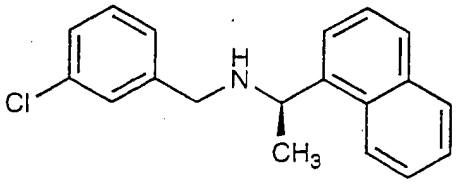


13K

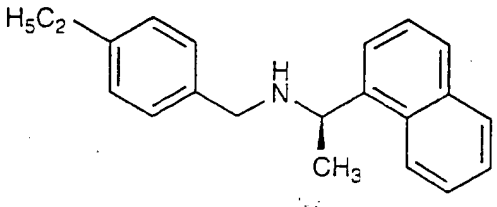


13L

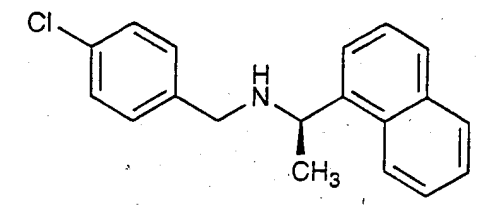
FIG. 13B.



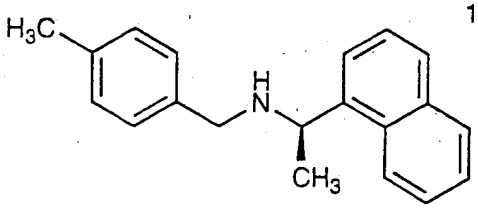
13M



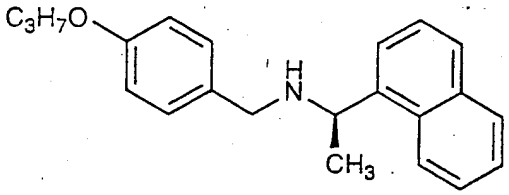
13N



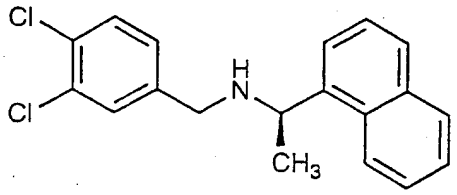
13O



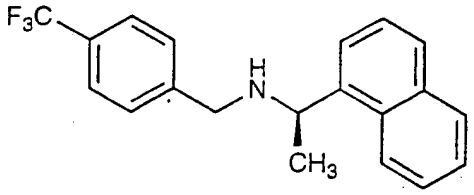
13P



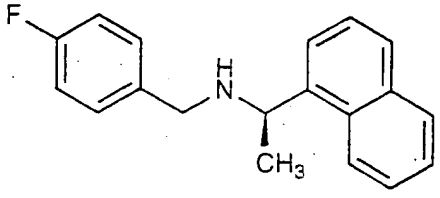
13Q



13R

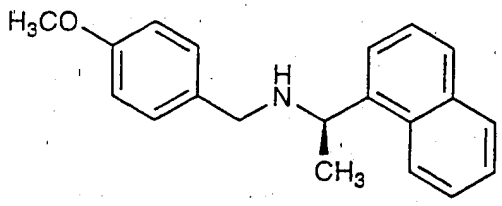


13S

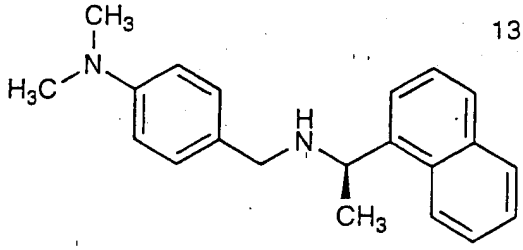


13T

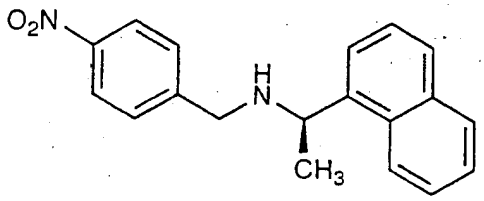
FIG. 13C.



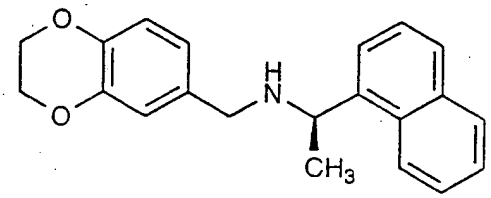
13U



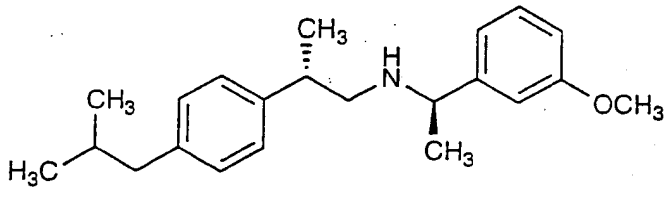
13V



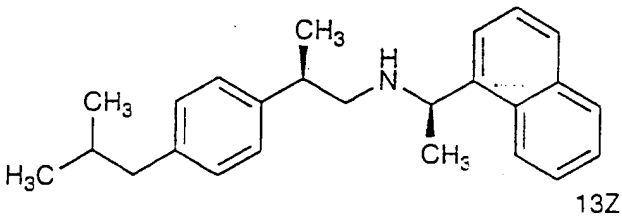
13W



13X

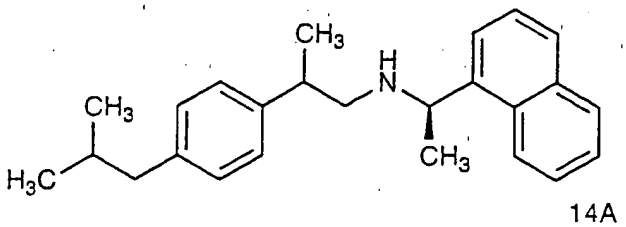


13Y

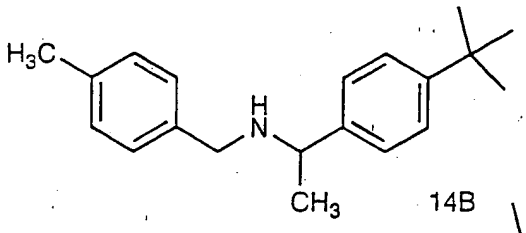


13Z

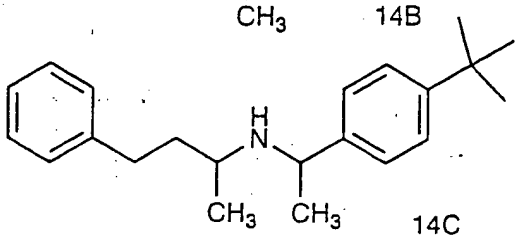
FIG. 13D.



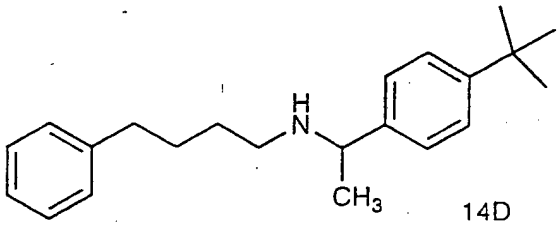
14A



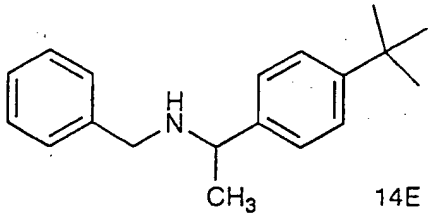
14B



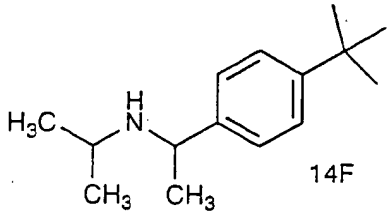
14C



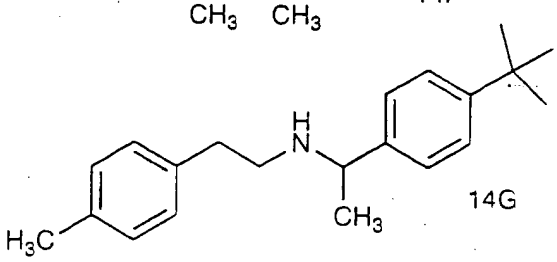
14D



14E

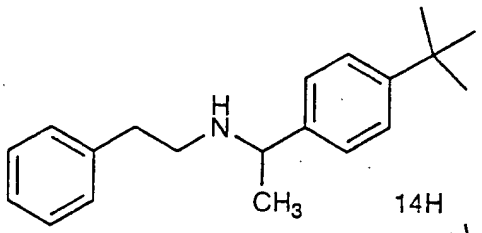


14F

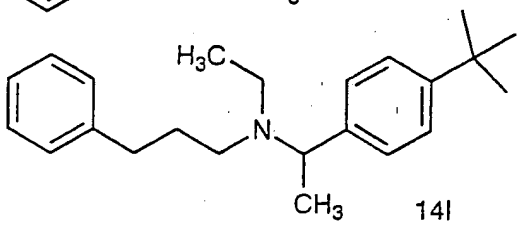


14G

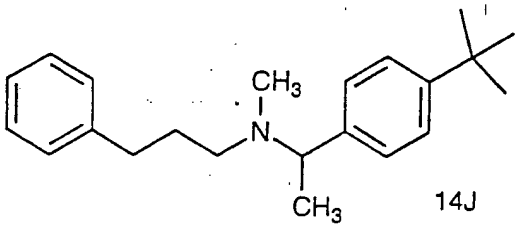
FIG. 14A.



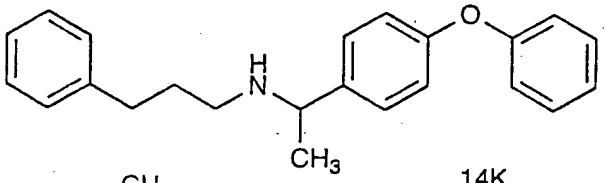
14H



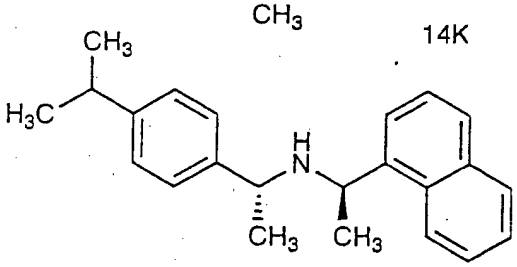
14I



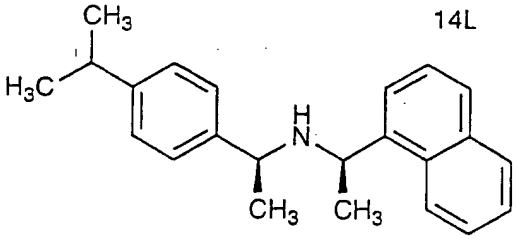
14J



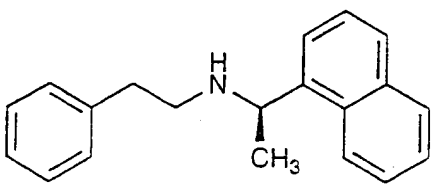
14K



14L

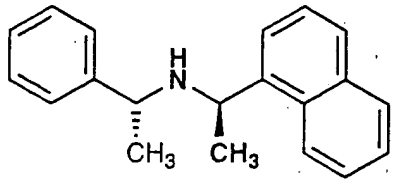


14M

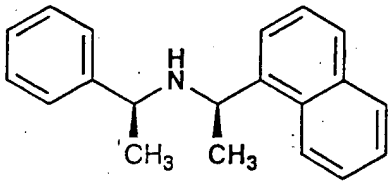


14N

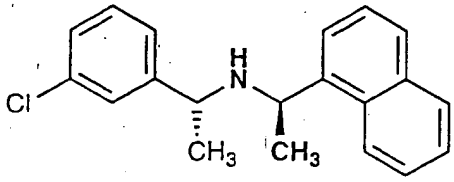
FIG. 14B.



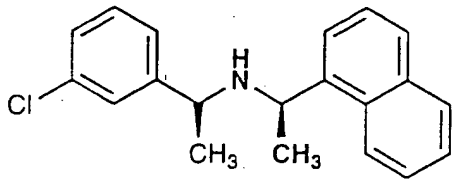
14O



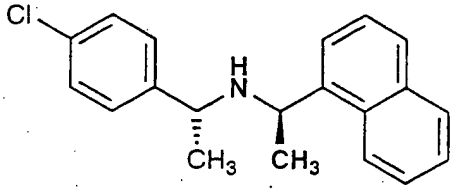
14P



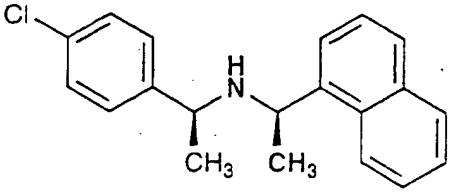
14Q



14R

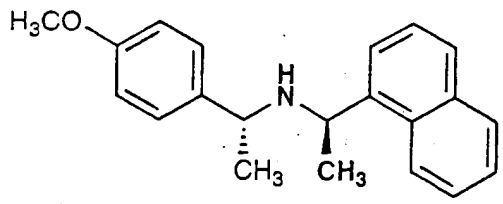


14S

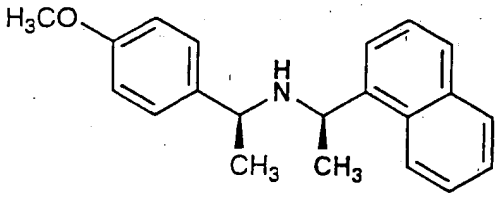


14T

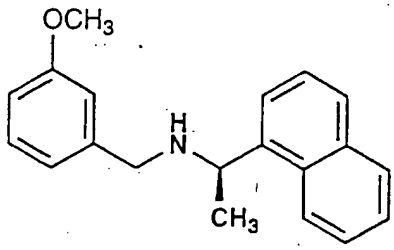
FIG. 14C.



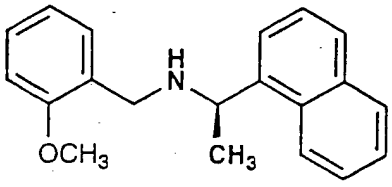
14U



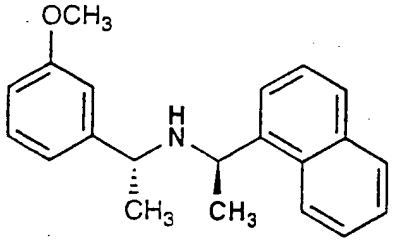
14V



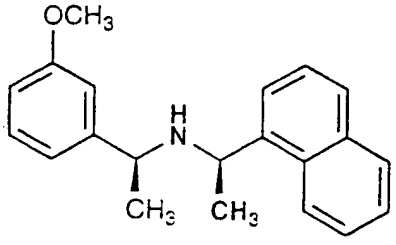
14W



14X

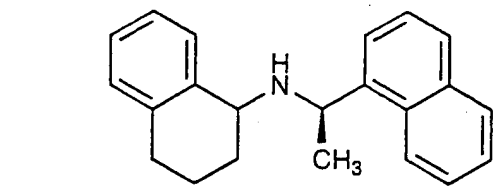


14Y

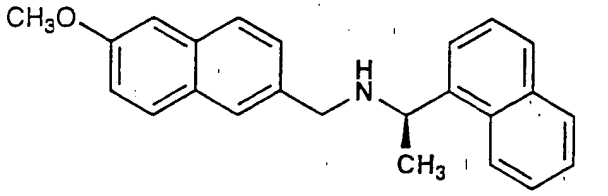


14Z

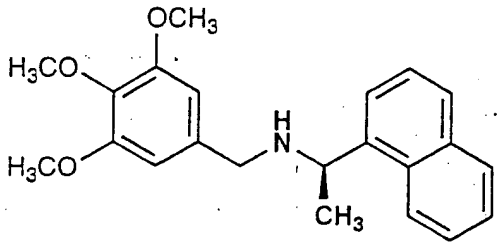
FIG. 14D.



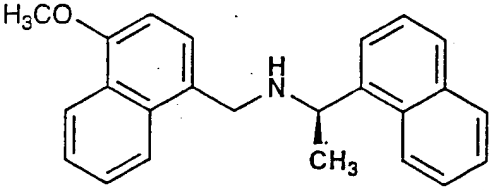
15A



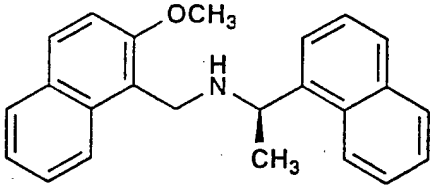
15B



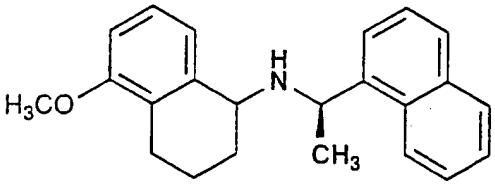
15C



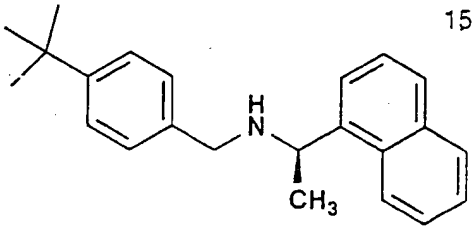
15D



15E



15F



15G

FIG. 15A.

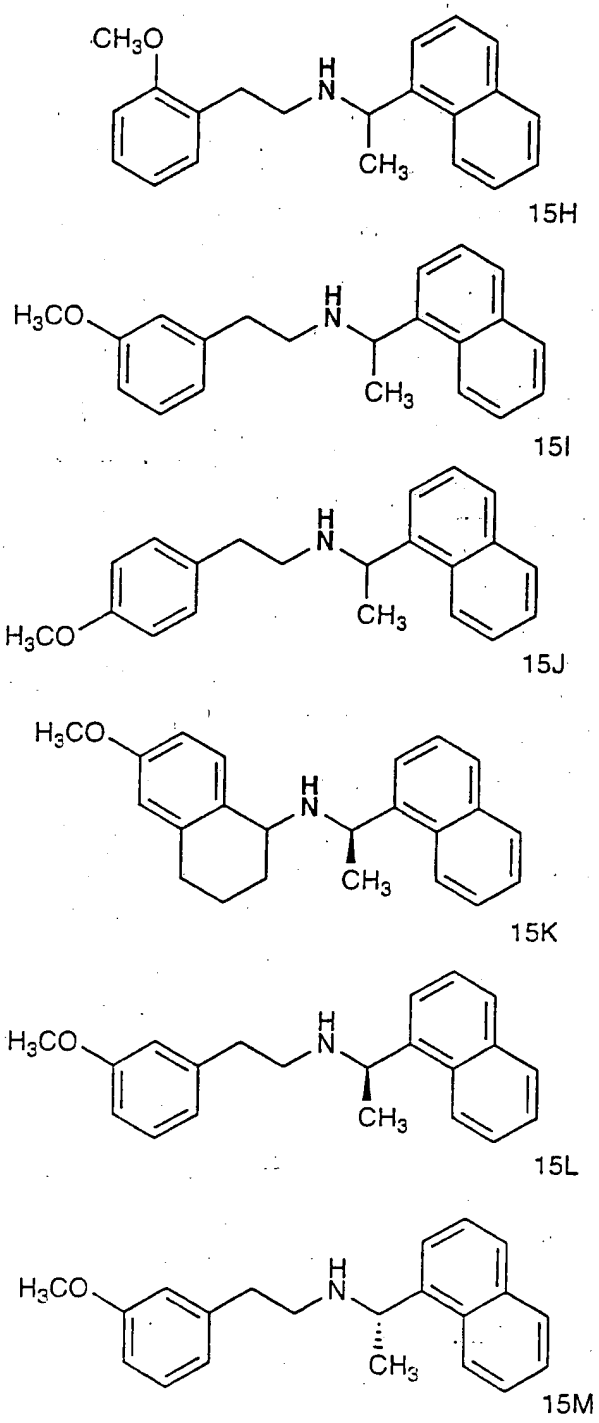
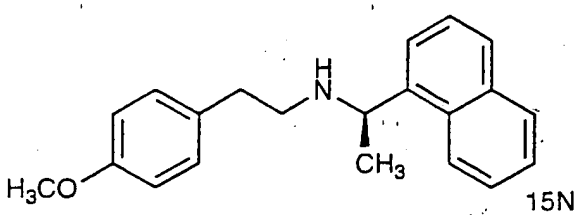
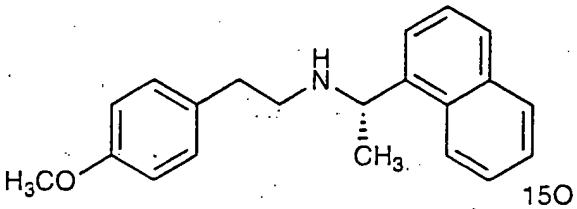


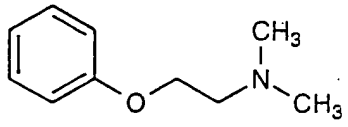
FIG. 15B.



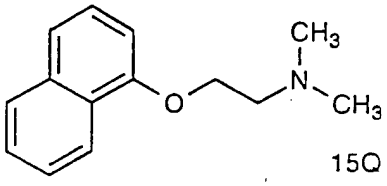
15N



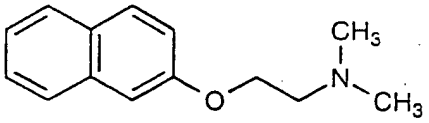
15O



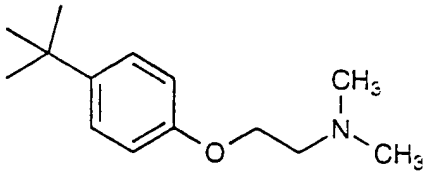
15P



15Q

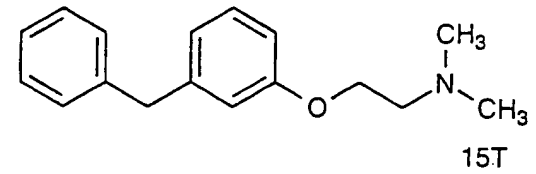


15R

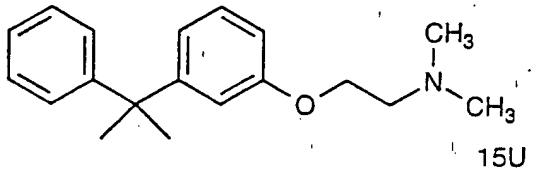


15S

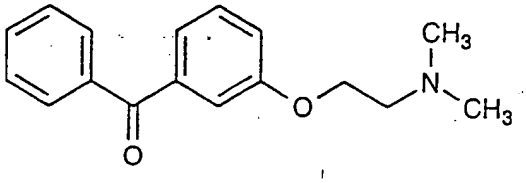
FIG. 15C.



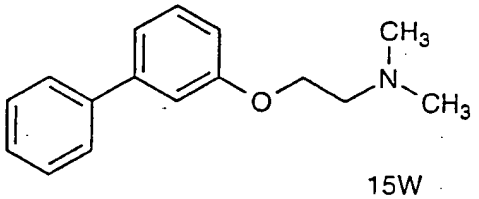
15T



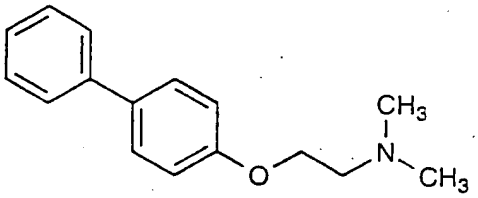
15U



15V



15W



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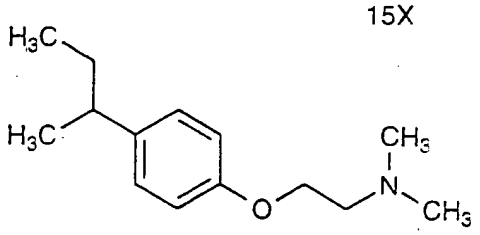
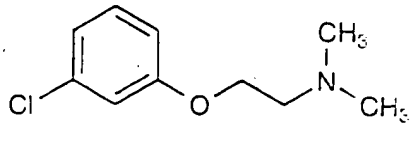
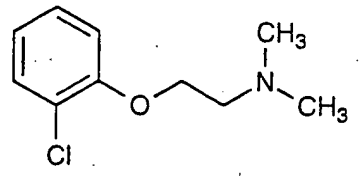


15Y

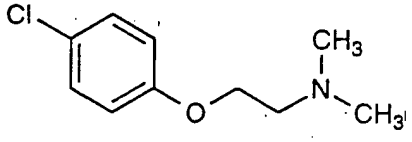


15Z

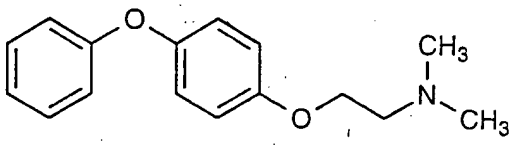
FIG. 15D.



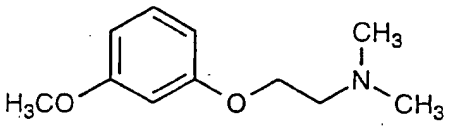
16A



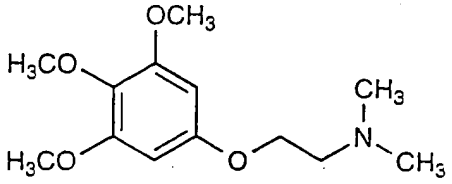
16B



16C

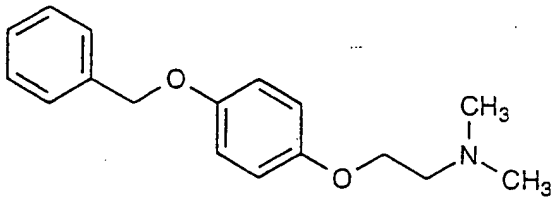


16D



16E

FIG. 16A.



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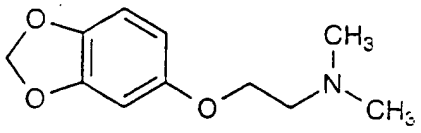
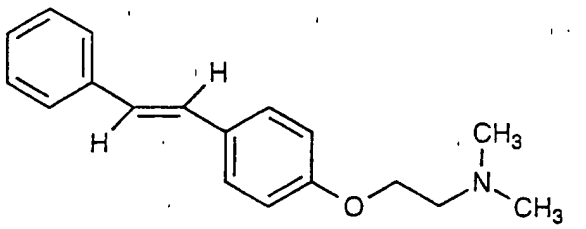
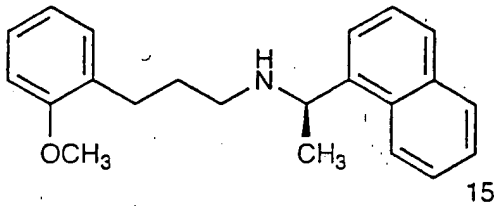


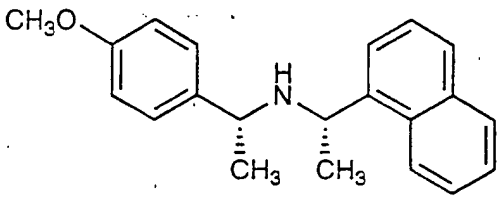
16G



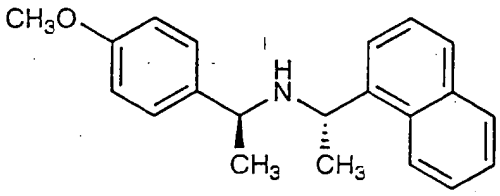
15H



15I

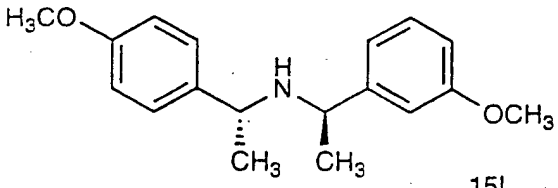


15J

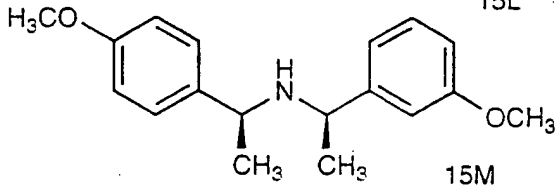


15K

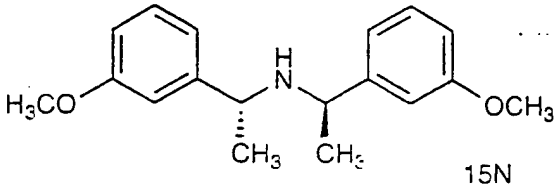
FIG. 16B.



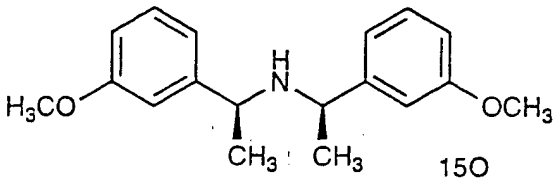
15L



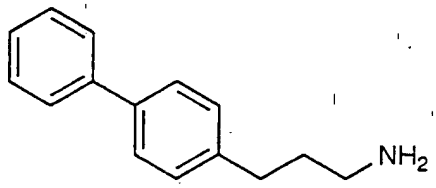
15M



15N



15O



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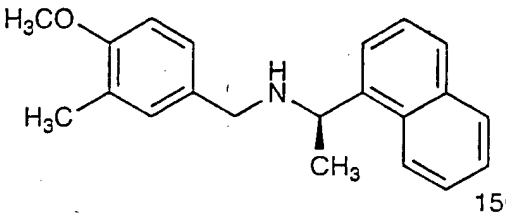
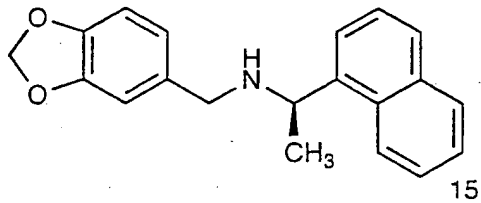
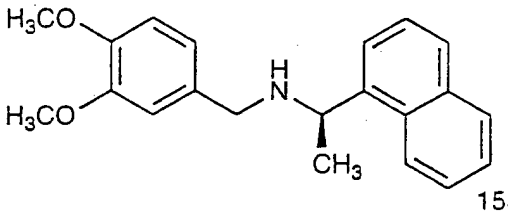


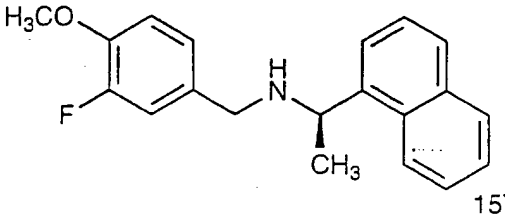
15Q



15R



15S



15T

FIG. 16C.

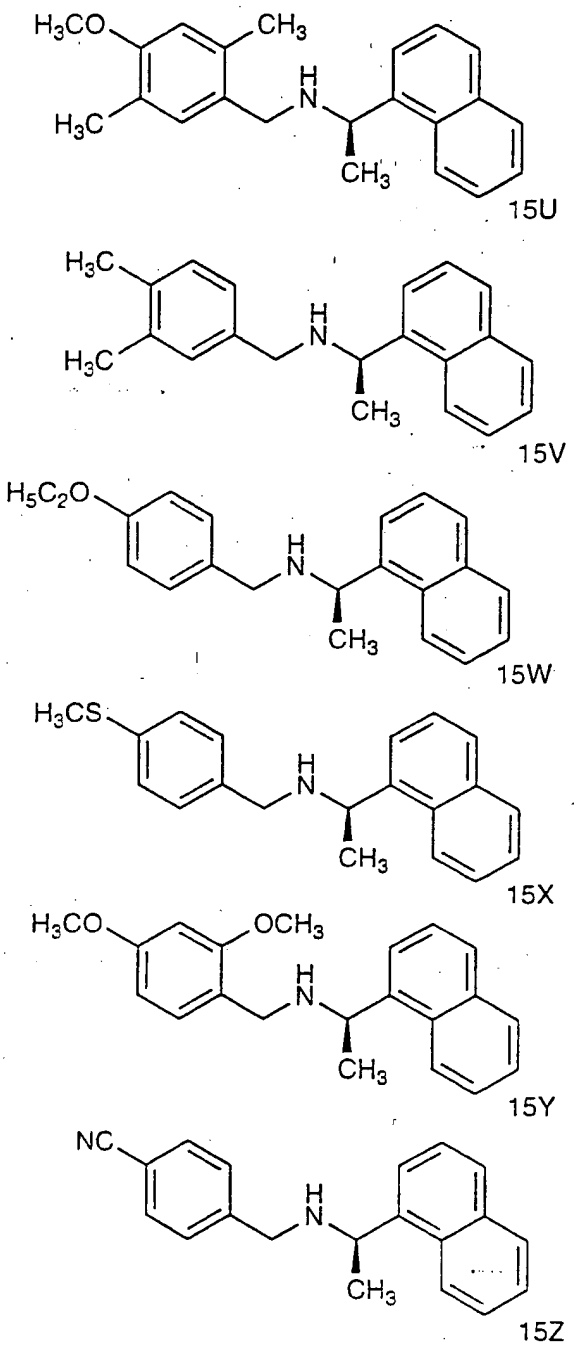

H3CO
CH3
H3C
HN
CH3
15U
H3C
H3C
HN
CH3
15V
H5C2O
HN
CH3
15W
H3CS
HN
CH3
15X
H3CO
OCH3
HN
CH3
15Y
NC
HN
CH3
15Z

FIG. 16D.

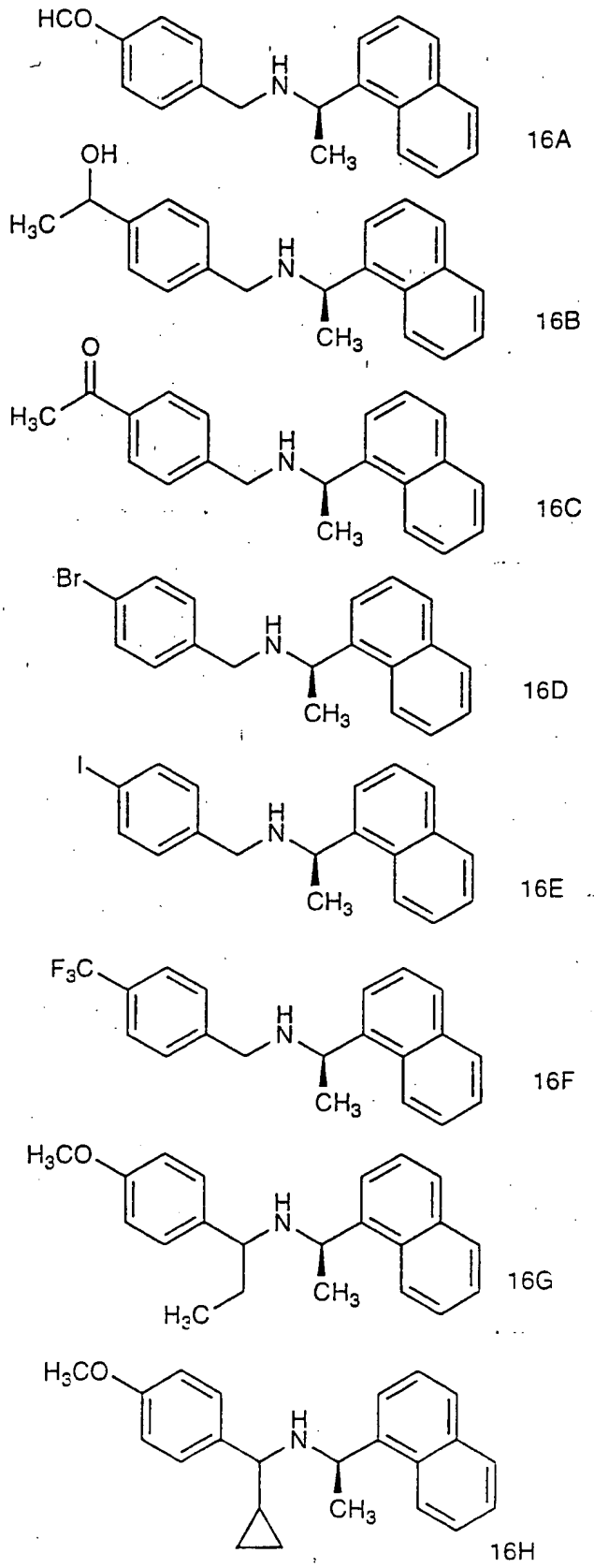
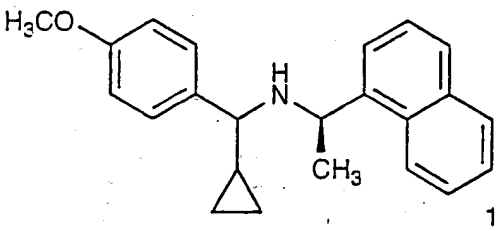
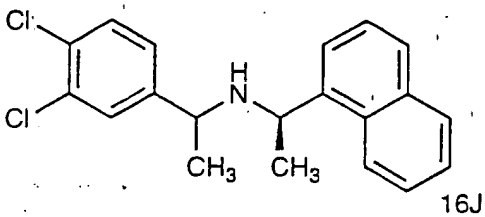


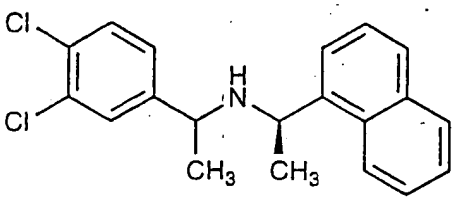
FIG. 17A.



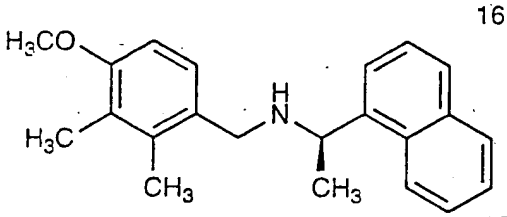
16I



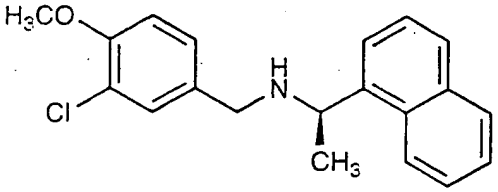
16J



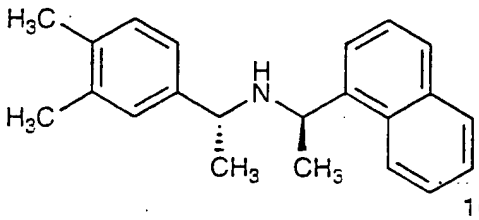
16K



16L



16M



16N

FIG. 17B.

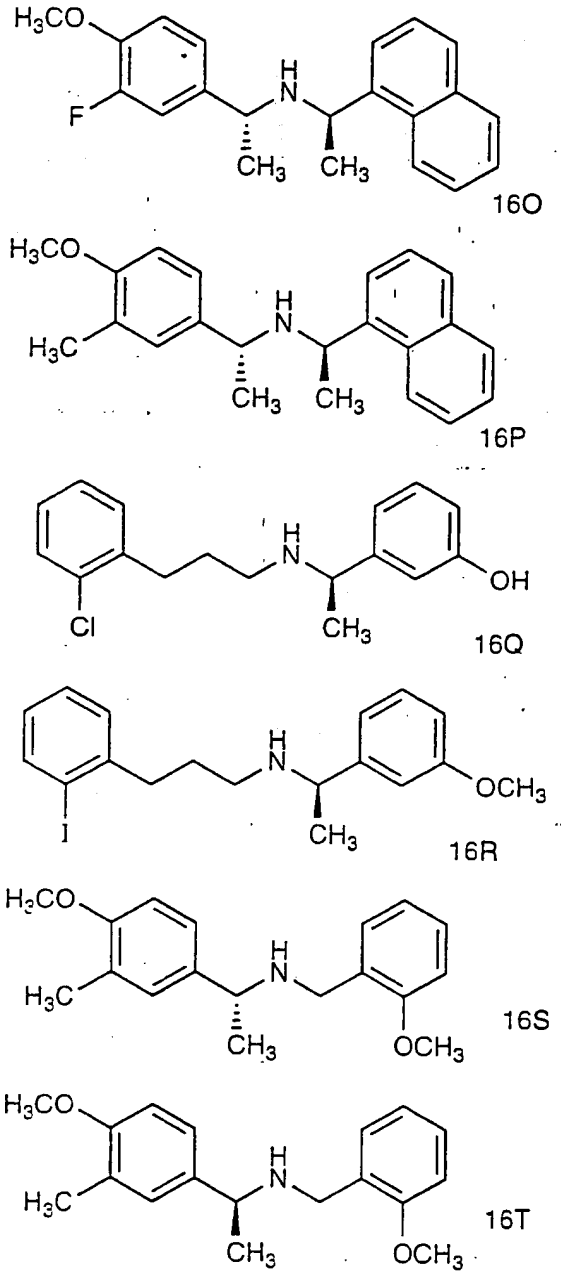


FIG. 17C.

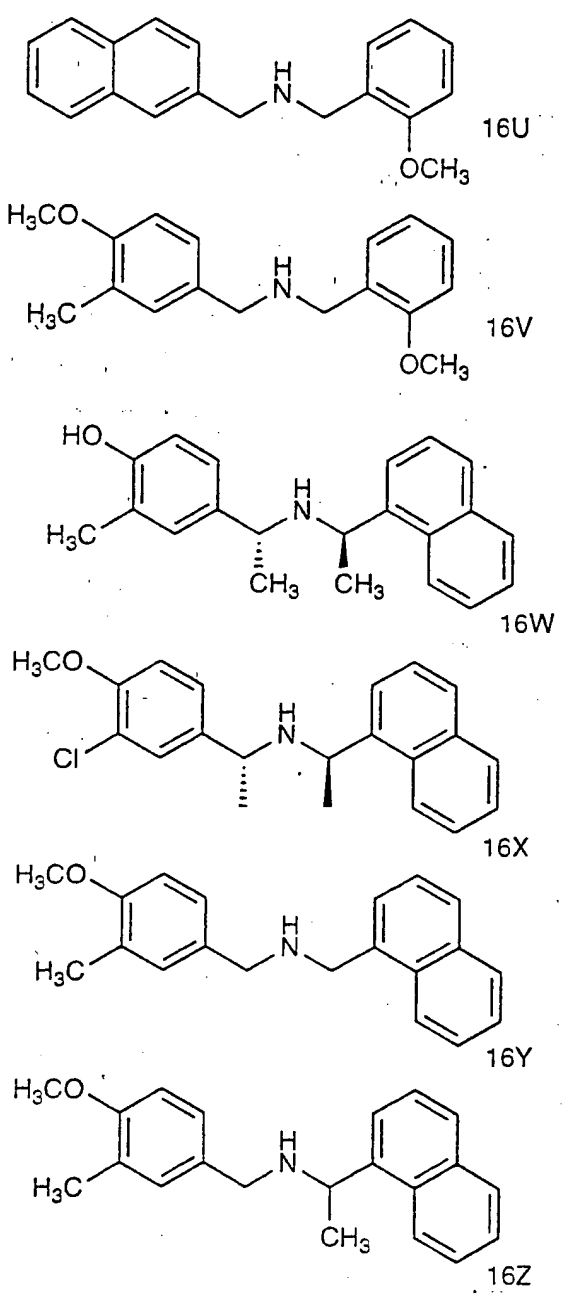
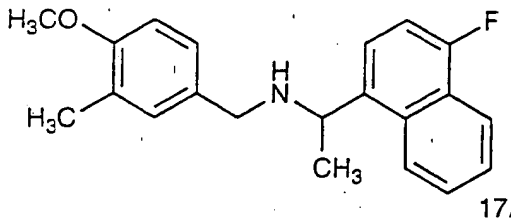
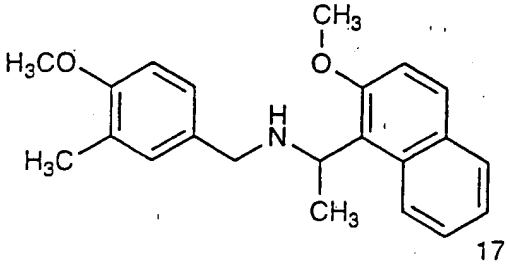


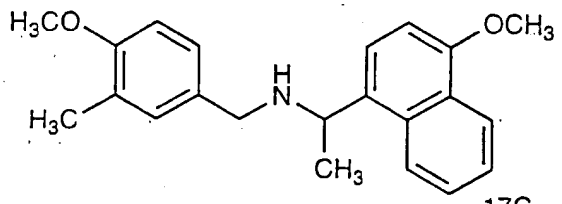
FIG. 17D.



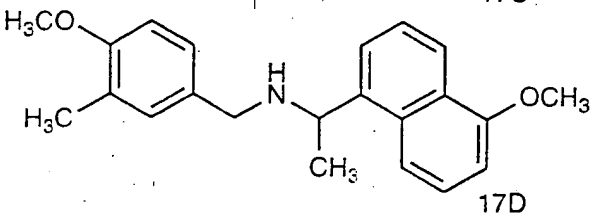
17A



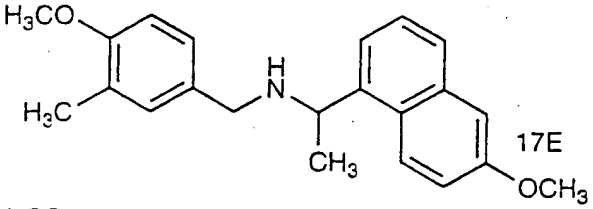
17B



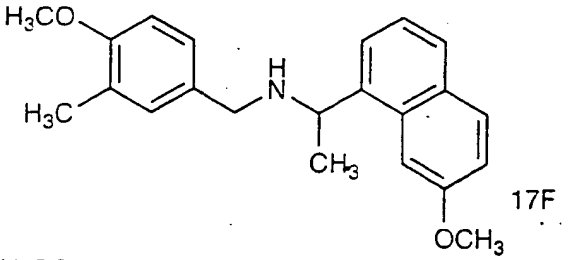
17C



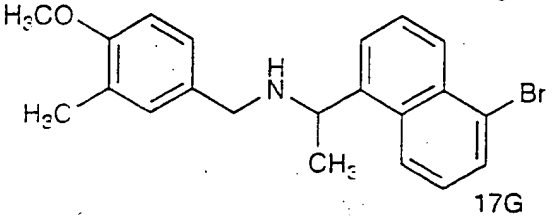
17D



17E

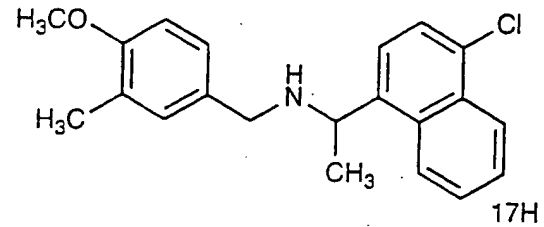


17F

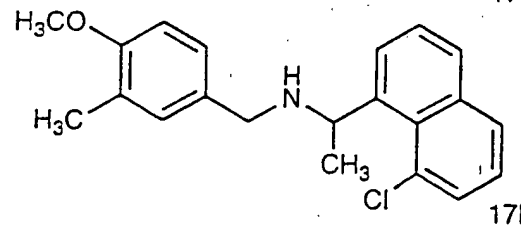


17G

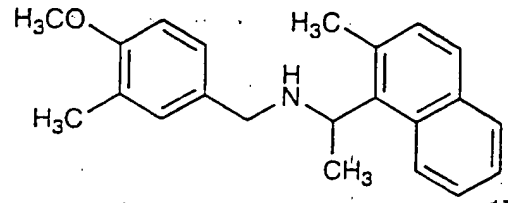
FIG. 18A.



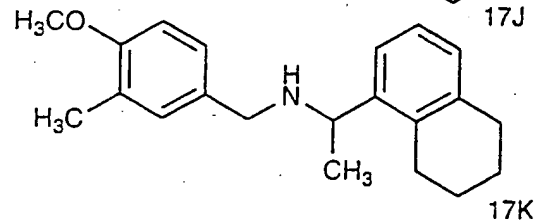
17H



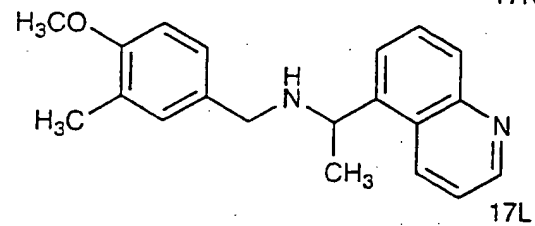
17I



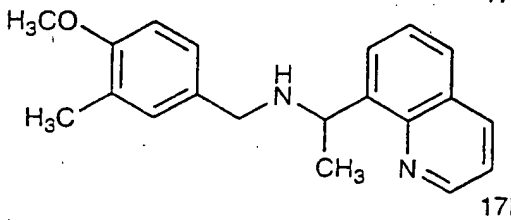
17J



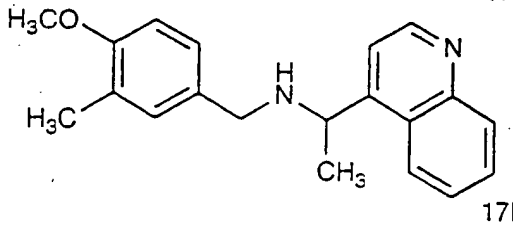
17K



17L

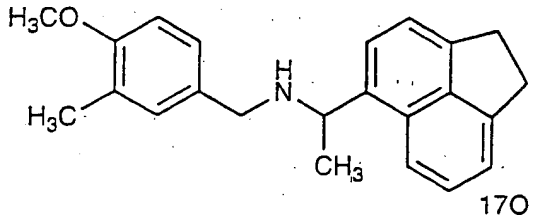


17M

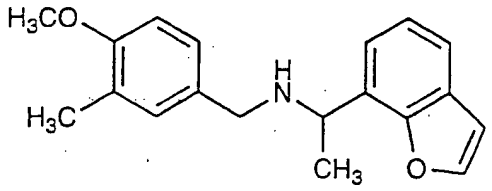


17N

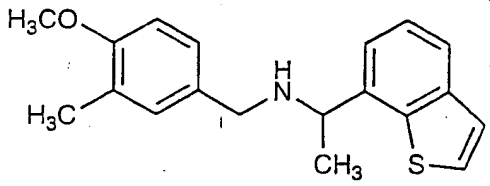
FIG. 18B.



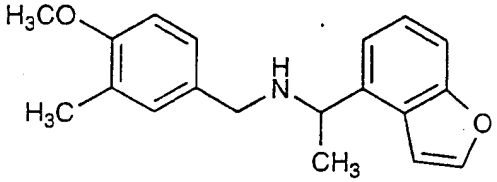
17O



17P



17Q



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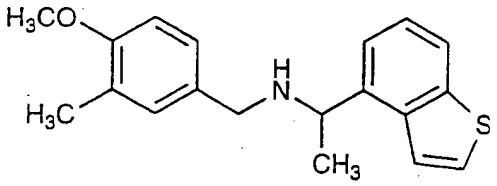
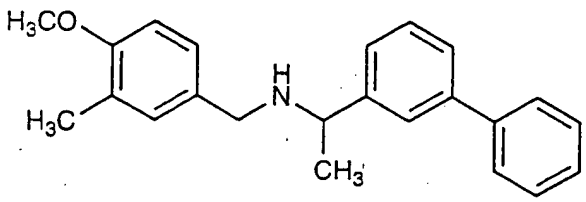


17S

FIG. 18C.



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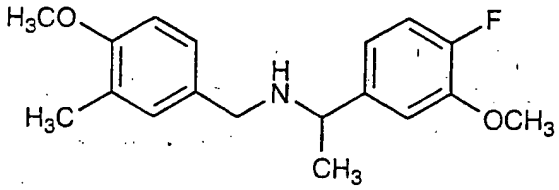

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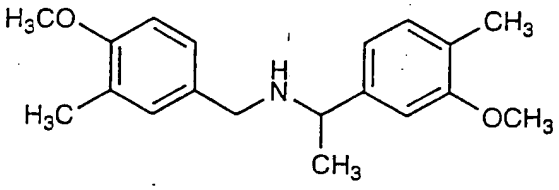

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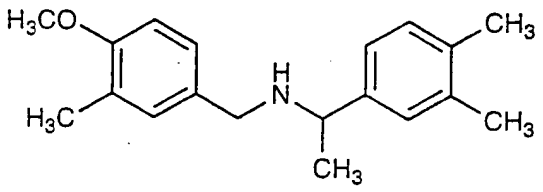

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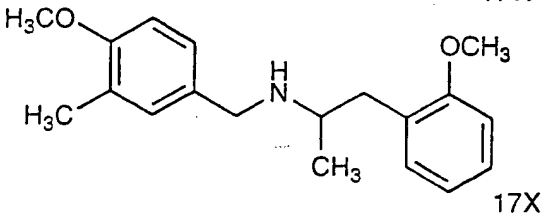
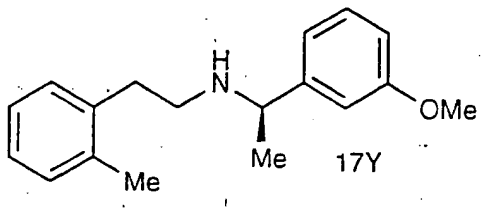


17X

FIG. 18D.



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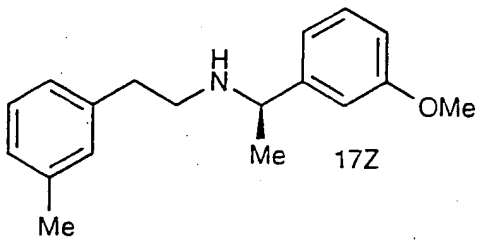

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FIG. 18E.

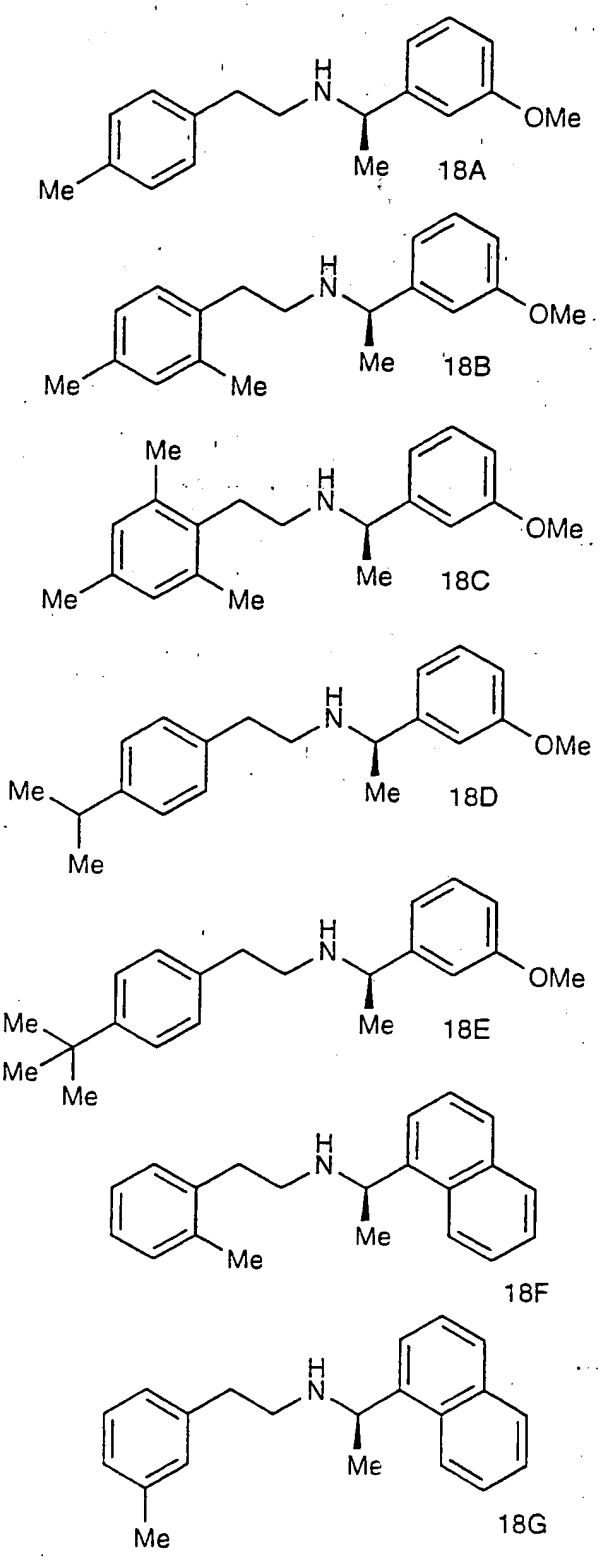
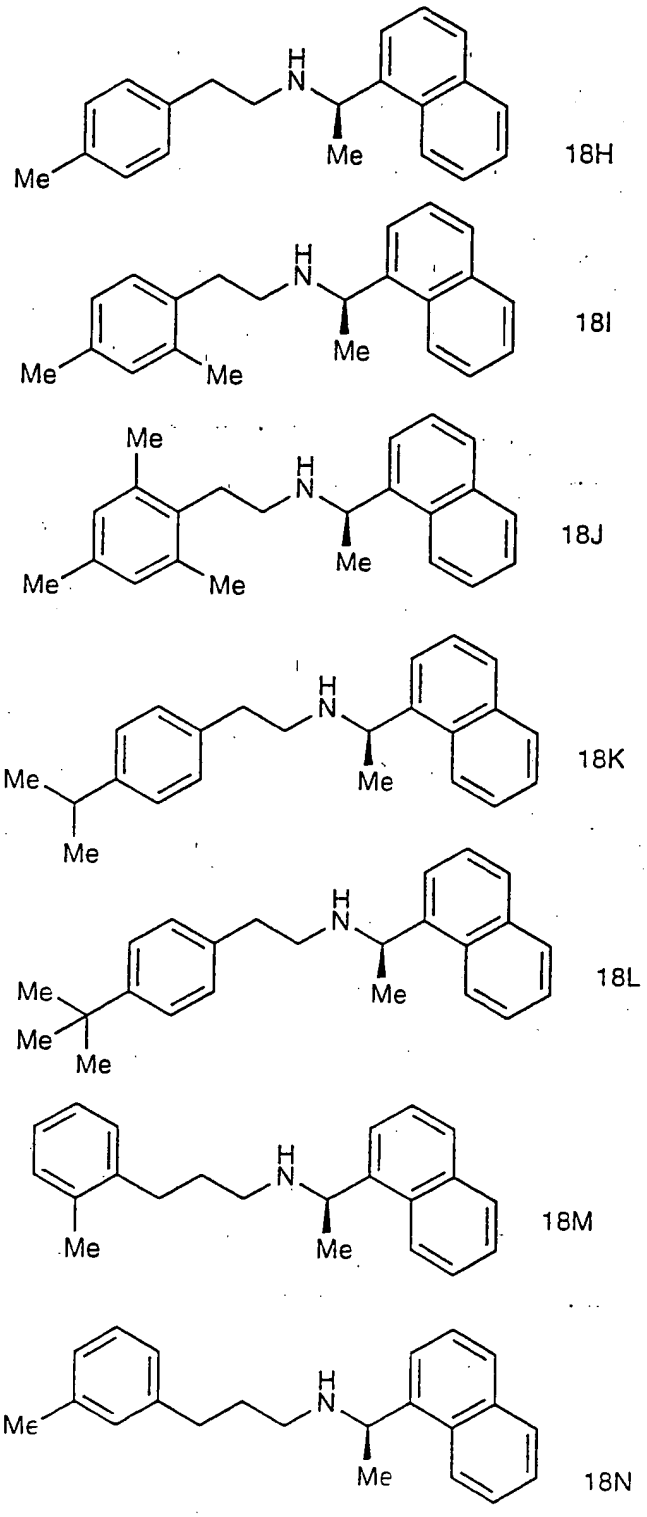


FIG. 19A.



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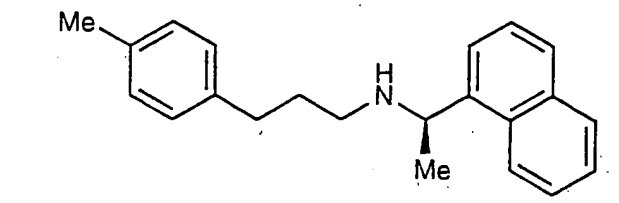

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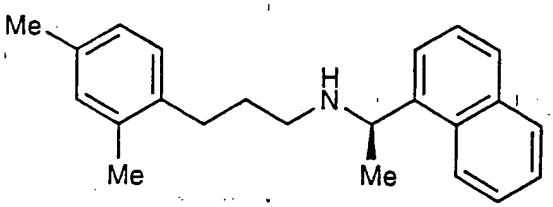

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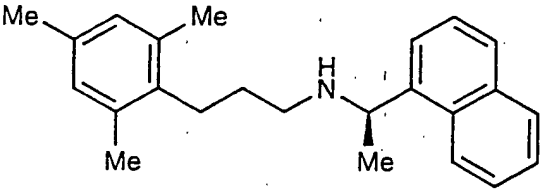

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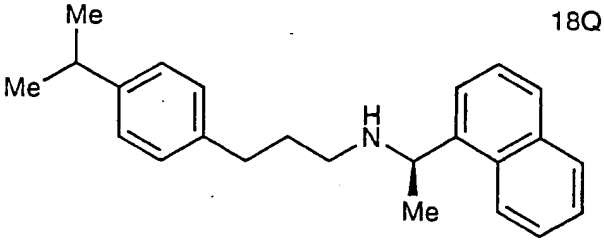

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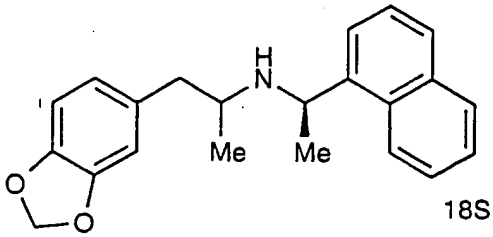

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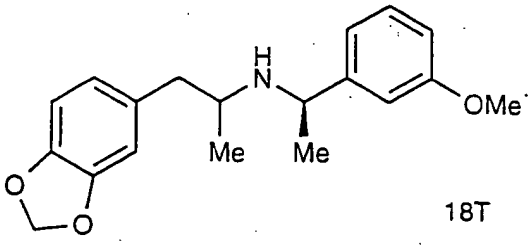

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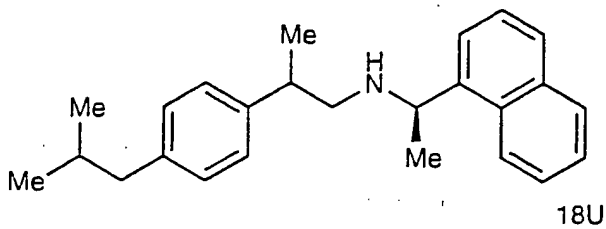
FIG. 19C.

RECTIFIED SHEET (RULE 91)
ISA / EP



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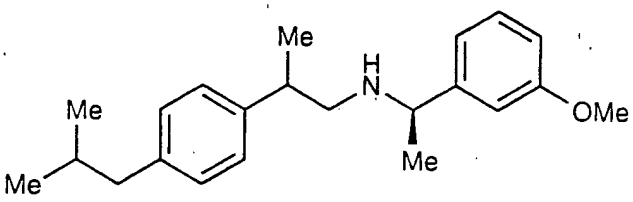

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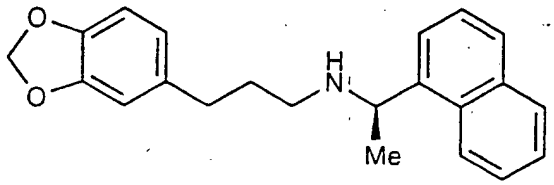

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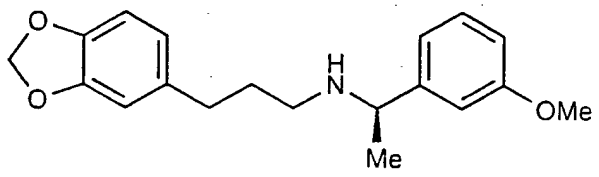

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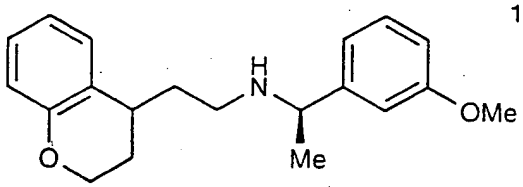

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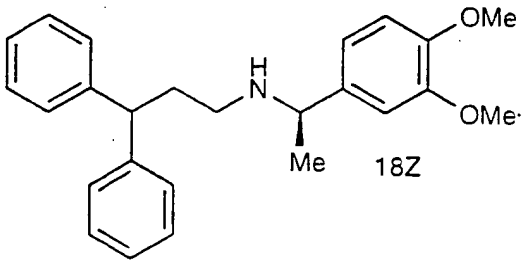
FIG. 19D.



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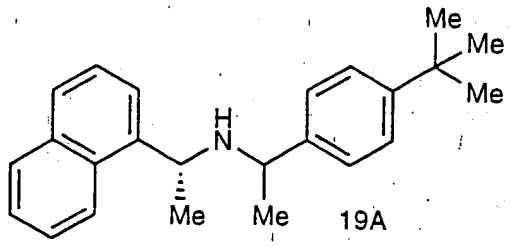

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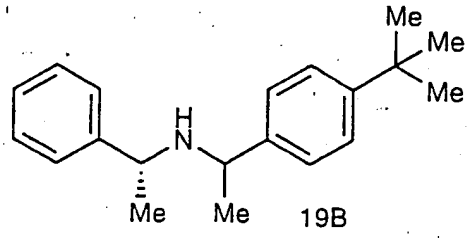

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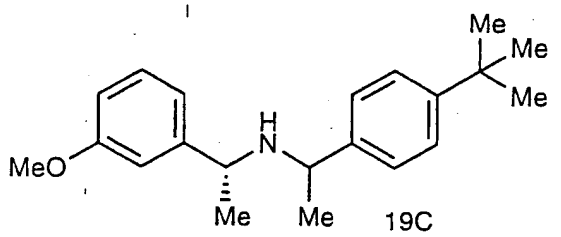

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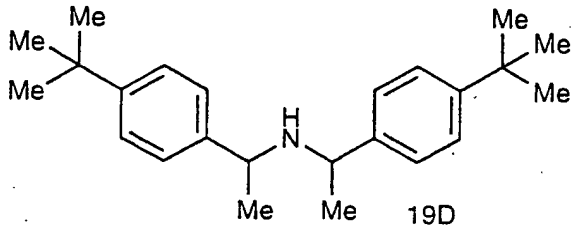
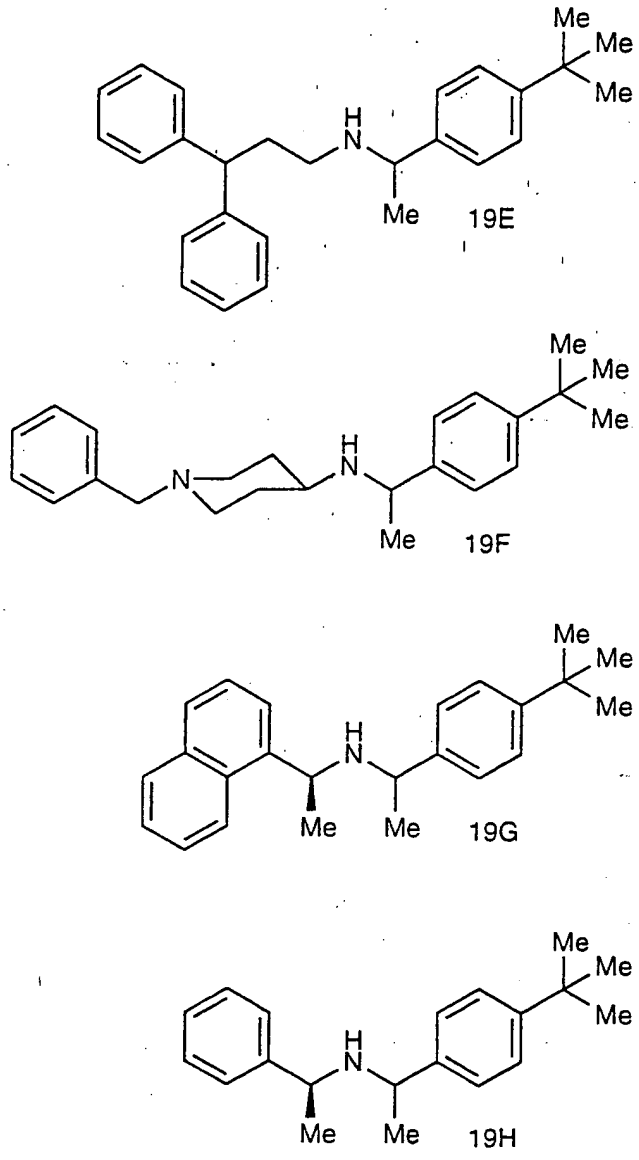


19D

FIG. 20A.



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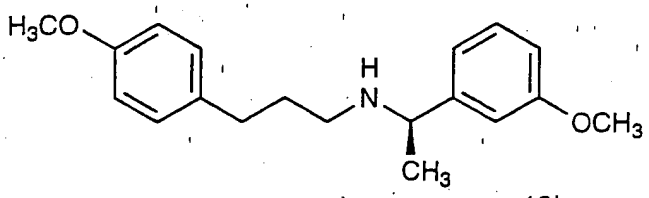

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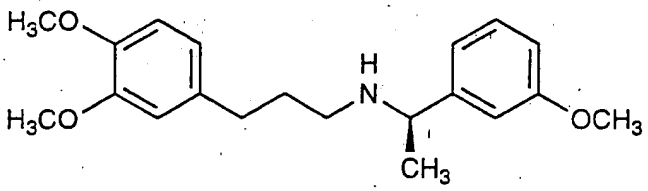

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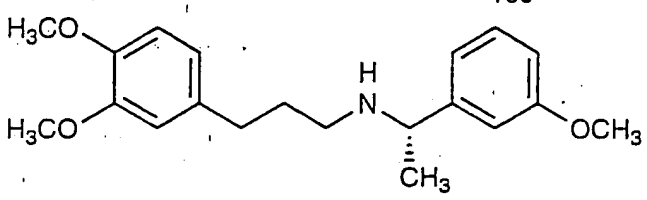

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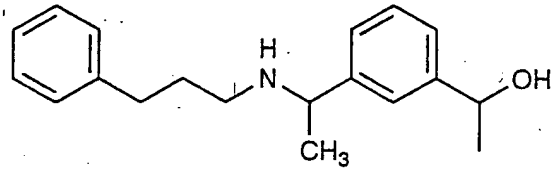

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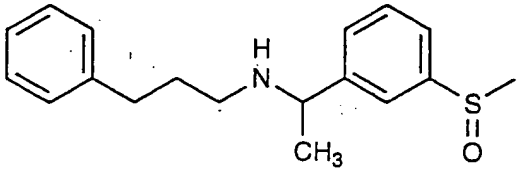

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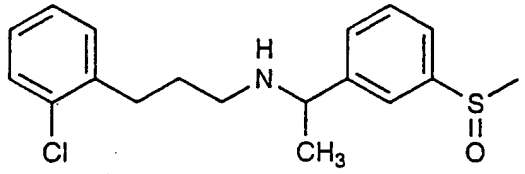

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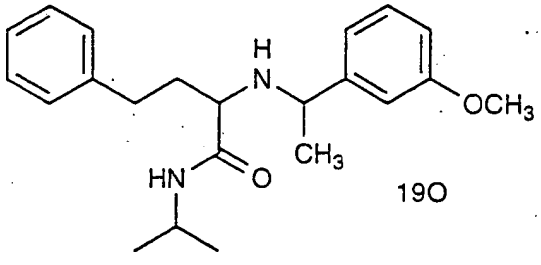
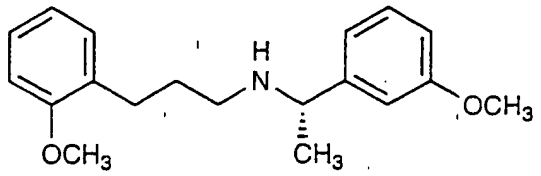


19O

FIG. 20C.



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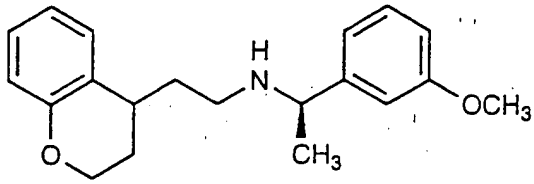

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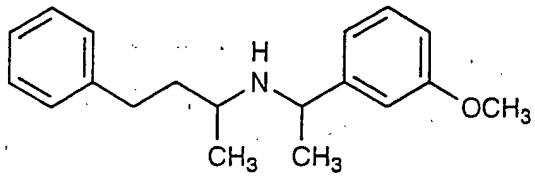

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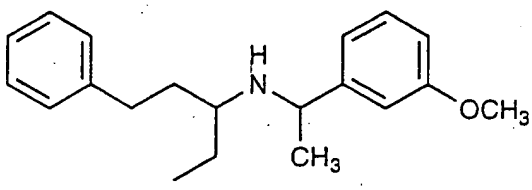

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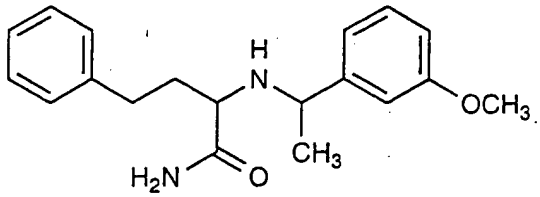

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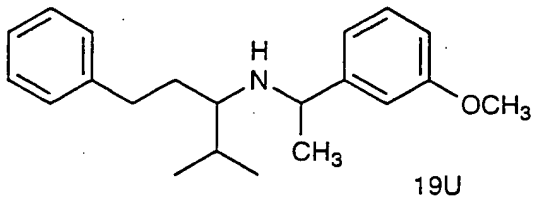

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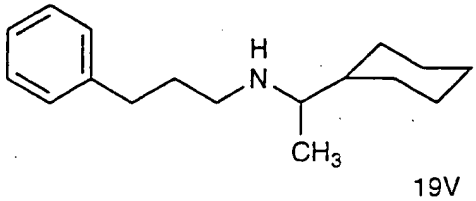
FIG. 20D.



19V

INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/US 94/12117

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07C211/30 C07C217/62 C07C217/58 C07C323/32 A61K31/13

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,93 04373 (NPS PHARMACEUTICALS) 4 March 1993 cited in the application see page 14, line 27 - page 17, line 14; claims 1,25,36,63,99 ---	1-19
X	TETRAHEDRON: ASYMMETRY, vol.2, no.3, 1991, OXFORD GB pages 183 - 186 S. G. DAVIES, O. ICHIHARA 'Asymmetric Synthesis of R-.beta.-Amino Butanoic Acid and S-.beta.-Tyrosine: Homochiral Lithium Amide Equivalents for Michael Addition to .alpha.,.beta.-Unsaturated Esters' see page 184, compounds 3,4,5 --- -/--	3

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 January 1995	- 9. 02. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Seufert, G

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	TETRAHEDRON, vol.41, no.24, 1985, OXFORD GB pages 6005 - 6011 J. C. G. VAN NIEL, U. K. PANDIT 'NADH Models XXI. Stereoselective Reduction of Chiral Imines with Hantzsch Ester' see page 6006, compounds 5a-e	3
X	JOURNAL OF ORGANIC CHEMISTRY, vol.51, no.25, 1986, EASTON US pages 4953 - 4959 S. H. BERTZ ET AL. 'Asymmetric Induction with Amidocuprates' see page 4955, table II, entry 11	3
X	GB,A,2 213 818 (E. R. SQUIBB & SONS INC.) 23 August 1989 see examples 1,3-15	3
X	LIEBIGS ANNALEN DER CHEMIE, no.8, 1990, WEINHEIM DE pages 795 - 805 G. BRINGMANN ET AL. 'The Enantioselective Synthesis of Optically Active, Benzene Nucleus-Substituted 1-Phenylethylamines from the corresponding Acetophenones' see page 798, table 2, compound ent-9k	3
X	SYNLETT, no.5, 1990, STUTTGART DE pages 253 - 255 G. BRINGMANN ET AL. 'Enantiomerically Pure N-Boc Protected .beta.-Keto-.gamma.-Amino Acid Esters from Simple Keto Precursors: Novel, Stereocontrolled Approach to Statine Derivatives with Any Desired Configuration' see page 254, compound ent-7a	3
X	TETRAHEDRON: ASYMMETRY, vol.3, no.2, 1992, OXFORD GB pages 235 - 238 CORNELIS LENSINK, J. G. DE VRIES 'Improving Enantioselectivity by Using a Mono-Sulphonated Diphosphine as Ligand for Homogeneous Imine Hydrogenation' see page 235, compound 3	3

-/--

2

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHEMICAL ABSTRACTS, vol. 116, no. 2, 13 January 1992, Columbus, Ohio, US; abstract no. 14742u, A. G. BECALSKI ET AL. page 558 ; see abstract and RN 137769-86-9 & INORGANIC CHEMISTRY, vol.30, no.26, EASTON US pages 5002 - 5008	3
X	EP,A,0 508 307 (SUMITOMO CHEMICAL COMPANY) 14 October 1992 see claim 1; examples	3
P,X	WO,A,94 18959 (NPS PHARMACEUTICALS) 4 March 1993 cited in the application see page 17, line 23 - page 19, line 23 see claims 1, 25-27, 30-36, 63-65, 68-73, 97, 99 see also RN 159149-96-9, 125275-99-2	1-19
P,X	SYNTHESIS, no.12, December 1993, STUTTGART DE pages 1243 - 1246 E. JUARISTI ET AL. 'Use of N,N'-Dimethylpropenylurea (DMPU) as Solvent in the Efficient Preparation of Enatiomerically Pure Secondary Amines' see page 1245, line 17 - line 25	3
P,X	CHEMICAL ABSTRACTS, vol. 121, no. 19, 7 November 1994, Columbus, Ohio, US; abstract no. 230462, Y. KOMEYOSHI, J. KUDO page 1060 ; see abstract and RN 158075-03-7, 158075-02-6,158075-01-5, 158074-98-7, 158074-97-6, 158074-96-5, 158074-95-4 & JP,A,6 116 214 (SUMITOMO CHEMICAL COMPANY) 26 April 1994	3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/12117

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Although claims 12-19 are directed to a method of treatment of the human body, the search has been carried out and based on the alleged effects of the compounds/compositions.

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter nal Application No
PCT/US 94/12117

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A-9304373	04-03-93	AU-A-	2588992	16-03-93
		CA-A-	2115828	04-03-93
		JP-T-	6510531	24-11-94
		NO-A-	940581	25-04-94
GB-A-2213818	23-08-89	US-A-	5001251	19-03-91
		GB-A,B	2245270	02-01-92
		US-A-	5097043	17-03-92
EP-A-0508307	14-10-92	JP-A-	5201938	10-08-93
		US-A-	5298660	29-03-94
WO-A-9418959	01-09-94	AU-B-	3777093	14-09-94
JP-A-6116214	26-04-94	NONE		